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19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Dam Safety National Dam Safety Program Visual Inspection Hydrology, Structural Stability		Beaver Dam Lake Orange County Hudson River
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report provides information and analysis on the physical condition of the dam as of the report date. Information and analysis are based on visual inspection of the dam by the performing organization. Examination of available documents and a visual inspection of the dam and the appurtenant structures did not reveal conditions which constitute an immediate hazard to human life or property. However, the dam has some deficiencies which require further investigation and remedial action.		

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Using Corps of Engineers screening criteria, it has been determined that the dam would be overtopped for all storms exceeding approximately 37 percent of Probable Maximum Flood (PMF). The spillway is, therefore, adjudged as "seriously inadequate" and the dam is assessed as unsafe, non-emergency.

The classification of "unsafe" applied to a dam because of a "seriously inadequate" spillway is not meant to connote the same degree of emergency as would be associated with an "unsafe" classification applied for a structural deficiency. It does mean, however, that based on an initial screening, and preliminary computations, there appears to be a serious deficiency in spillway capacity so that if a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard to loss of life downstream from the dam.

On the basis of stability analysis performed during the investigation the structural stability of the spillway section against overturning was determined to be inadequate for all cases except the normal loading with and without earthquake. Also, the sliding stability is inadequate for all loading conditions.

It is, therefore, recommended that within three months from the date of notification to the owner, detailed hydrological hydraulic investigations of the structure should be undertaken to more accurately determine the site specific characteristics of the watershed and their affect upon the overtopping potential of the dam. At the same time, further analysis of the structural stability of the spillway should be performed. Analysis should include field investigations to obtain more information regarding the extent and magnitude of uplift pressures under the base of the spillway, the quality of the foundation materials, the geometry of the spillway structure, and the condition of the masonry and concrete. Within twelve months of the date of notification to the owner, modifications to the structure, deemed necessary as a result of studies, should have been completed. In the interim, a detailed emergency operation plan and warning system should be promptly developed. Also, during periods of unusually heavy precipitation, around-the-clock surveillance should be provided.

In addition, the dam has a number of problem areas which, if left uncorrected, have the potential for the development of hazardous conditions and must be corrected within twelve months.

1. Repair and also provide controls for the reservoir drains.
2. Monitor, bi-weekly, the seepage at the downstream face of the spillway.
3. Determine the source of seepage occurring downstream of the east buttress toe. Monitor the seepage bi-weekly with the aid of weirs.
4. Repair spalled areas at the crest and downstream face of the dam.
5. Repair the upstream face of dam and spillway training walls pointing.
6. Repair the right and middle training walls.
7. Repair cracks at the right spillway training wall.
8. Remove vegetation from the crest of spillway, slope, and toe of dam. Provide a program of periodic cutting and mowing of the buttress surfaces.

AD A092225

HUDSON RIVER BASIN

BEAVER DAM LAKE

ORANGE COUNTY, NEW YORK

INVENTORY NO. N.Y. 619

**PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM**



NEW YORK DISTRICT CORPS OF ENGINEERS

AUGUST 1980

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(10) Eugene / O'Brien

(6)

HUDSON RIVER BASIN

National Dam Safety Program.

BEAVER DAM LAKE

ORANGE COUNTY, NEW YORK

(INVENTORY ^{Number} ~~NO~~ N.Y. 619)

Hudson River Basin,

Orange County, New York.

PHASE I INSPECTION REPORT,

NATIONAL DAM SAFETY PROGRAM

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NEW YORK DISTRICT CORPS OF ENGINEERS

AUGUST 1980

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C., 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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NATIONAL DAM SAFETY PROGRAM
BEAVER DAM LAKE
I.D. NO.: N.Y. 619
D.E.C. #502
HUDSON RIVER BASIN
ORANGE COUNTY, NEW YORK
PHASE I INSPECTION REPORT

CONTENTS

	<u>Page No.</u>
- ASSESSMENT	-
- OVERVIEW PHOTOGRAPH	-
1 PROJECT INFORMATION	1
1.1 GENERAL	
a. Authority	1
b. Purpose of Inspection	1
1.2 DESCRIPTION OF PROJECT	1
a. Description of Dam	1
b. Location	2
c. Size Classification	2
d. Hazard Classification	2
e. Ownership	2
f. Purpose of Dam	2
g. Design and Construction History	3
h. Normal Operational Procedures	3
1.3 PERTINENT DATA	3
a. Drainage Area	3
b. Discharge at Dam	3
c. Elevation	3
d. Reservoir	3
e. Storage	3
f. Dam	3
g. Spillways	4
h. Reservoir Drains	4
2. ENGINEERING DATA	
2.1 GEOLOGY	5
2.2 SUBSURFACE INVESTIGATION	5
2.3 DESIGN RECORDS	5

	<u>Page No.</u>
2.4 CONSTRUCTION RECORDS	5
2.5 OPERATION RECORDS	5
2.6 EVALUATION OF DATA	5
3 VISUAL INSPECTION	7
3.1 FINDINGS	7
a. General	7
b. Dam	7
c. Spillway	7
d. Appurtenant Structures	8
e. Abutments	8
f. Downstream Channel	8
g. Reservoir Area	8
3.2 EVALUATION OF OBSERVATIONS	8
4. OPERATION AND MAINTENANCE PROCEDURES	10
4.1 PROCEDURES	10
4.2 MAINTENANCE OF DAM AND SPILLWAYS	10
4.3 WARNING SYSTEM IN EFFECT	10
4.4 EVALUATION	10
5. HYDROLOGIC/HYDRAULIC	11
5.1 DRAINAGE AREA CHARACTERISTICS	11
5.2 ANALYSIS CRITERIA	11
5.3 SPILLWAY CAPACITY	11
5.4 RESERVOIR CAPACITY	11
5.5 FLOODS OF RECORD	11
5.6 OVERTOPPING POTENTIAL	12
5.7 EVALUATION	12
6. STRUCTURAL STABILITY	13
6.1 EVALUATION OF STRUCTURAL STABILITY	13
a. Visual Observation	13
b. Design and Construction Data	13
c. Stability Analysis	13
d. Operation Records	14
e. Post-Construction Changes	14
f. Seismic Stability	14

		<u>Page No.</u>
7	ASSESSMENT/RECOMMENDATIONS	15
7.1	ASSESSMENT	15
a.	Safety	15
b.	Adequacy of Information	15
c.	Need for Additional Investigations	15
d.	Urgency	15
7.2	RECOMMENDED MEASURES	15

APPENDICES

- A. DRAWINGS
 - a. Vicinity Map
 - b. Topographic Map
 - c. Beaver Dam Lake-Plan
 - d. Beaver Dam Lake-Spillway Section
- B. 1912 DOCUMENT
- C. PHOTOGRAPHS
- D. VISUAL INSPECTION CHECKLIST
- E. HYDROLOGIC DATA AND COMPUTATIONS
- F. STABILITY ANALYSIS
- G. REFERENCES

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Beaver Dam Lake (I.D. No. 619)
State Located:	New York
County Located:	Orange
Stream:	Tributary of Moodna
Basin:	Hudson River
Date of Inspection:	April 24, 1980

ASSESSMENT

Examination of available documents and a visual inspection of the dam and the appurtenant structures did not reveal conditions which constitute an immediate hazard to human life or property. However, the dam has some deficiencies which require further investigation and remedial action.

Using Corps of Engineers screening criteria, it has been determined that the dam would be overtopped for all storms exceeding approximately 37 percent of Probable Maximum Flood (PMF). The spillway is, therefore, adjudged as "seriously inadequate" and the dam is assessed as unsafe, non-emergency.

The classification of "unsafe" applied to a dam because of a "seriously inadequate" spillway is not meant to connote the same degree of emergency as would be associated with an "unsafe" classification applied for a structural deficiency. It does mean, however, that based on an initial screening, and preliminary computations, there appears to be a serious deficiency in spillway capacity so that if a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard to loss of life downstream from the dam.

On the basis of stability analysis performed during the investigation the structural stability of the spillway section against overturning was determined to be inadequate for all cases except the normal loading with and without earthquake. Also, the sliding stability is inadequate for all loading conditions.

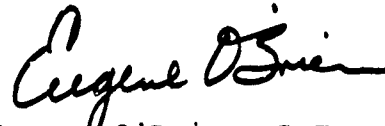
It is, therefore, recommended that within three months from the date of notification to the owner, detailed hydrological hydraulic investigations of the structure should be undertaken to more accurately determine the site specific characteristics of the watershed and their affect upon the overtopping potential of the dam. At the

same time, further analysis of the structural stability of the spillway should be performed. Analysis should include field investigations to obtain more information regarding the extent and magnitude of uplift pressures under the base of the spillway, the quality of the foundation materials, the geometry of the spillway structure, and the condition of the masonry and concrete. Within twelve months of the date of notification to the owner, modifications to the structure, deemed necessary as a result of studies, should have been completed. In the interim, a detailed emergency operation plan and warning system should be promptly developed. Also, during periods of unusually heavy precipitation, around-the-clock surveillance should be provided.

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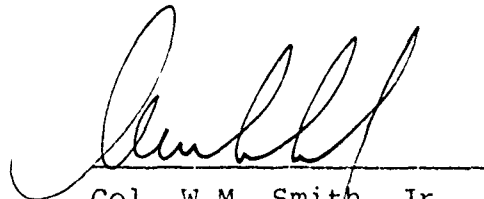
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5. Repair the upstream face of dam and spillway training walls pointing.
6. Repair the right and middle training walls.
7. Repair cracks at the right spillway training wall.
8. Remove vegetation from the crest of spillway, slope, and toe of dam. Provide a program of periodic cutting and mowing of the buttress surfaces.

9. Provide a program of periodic inspection and maintenance of the dam and appurtenances, including yearly operation and lubrication of the reservoir drain systems. Document this information for future reference. The aforementioned emergency action plan should be maintained and updated periodically during the life of the structure.



Eugene O'Brien, P.E.
New York No. 29823

Approved by:



Col. W.M. Smith, Jr.
New York District Engineer

Date:

11 Sep 88



1. OVERVIEW OF DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
BEAVER DAM LAKE
I.D. NO. N.Y. 619
D.E.C. #502
HUDSON RIVER BASIN
ORANGE COUNTY, NEW YORK

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority

The Phase I inspection reported herein was authorized by the State of New York, Department of Environmental Conservation, by letter dated 7 January 1980, in fulfillment of the requirements of the National Dam Inspection Act, Public Law 92-367, 8 August 1972.

b. Purpose of Inspection

This inspection was conducted to evaluate the existing conditions of the dam, to identify deficiencies and hazardous conditions, to determine if these deficiencies constitute hazards to life and property, and to recommend remedial measures where required.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam

The Beaver Dam Lake, formerly known as Salisbury Mills Dam, consists of left and right non-overflow sections with an included spillway. The dam is about 335 feet long with a maximum height of about 35 feet. The width of the wall at its top, which is also the crest of dam, varies from 3.5 feet to 3.75 feet. According to available documents, the upstream face of the wall is vertical to a depth of 8'-6" below the crest, and battered upstream at a slope of about 9.6(V) to 1(H) below. The exposed upstream face of the wall is brick faced. The crest of the earth buttress varies from 1 foot to about 6 feet below the top of the wall. The crest width of the buttress averages about 7 feet. The exposed downstream wall at both wings is vertical. The slopes of the left and right earth buttresses average about 1(V) : 1.5(H) and 1(V) : 2.0(H), respectively. In some areas the slope is protected by loosely placed stones. According to available documents, the dam is founded on a "hard pan" (glacial till).

The principal spillway is an ungated masonry and concrete gravity structure which is divided into two sections by an 8-foot wide stepped brick pier. The left and right spillway sections are about 30 feet and 35 feet long, respectively. The crest of both sections of the spillway is about 7 feet below the top of the dam; the sill of both of the sections is about 6 feet wide. Downstream of the spillway weir wall is a stepped concrete apron about 30 feet long.

The 4.5 foot wide downstream right training wall of the spillway is straight and is brick (5 steps) and concrete (1 step). The 8.0 foot-wide middle brick pier is stepped. The left training wall is constructed of stone masonry and is sloped. There are no upstream training walls.

Discharge over the spillway and concrete apron flows into a natural channel and continues under a 10-foot high by 8-foot wide roadway (Lake Road) concrete culvert located about 500 feet downstream from the dam. The channel then joins the Moodna Creek which is a tributary of the Hudson River.

At the right abutment, where the dam ends, there is an 86-foot long, 4-foot wide concrete abutment wall which is upstream and perpendicular to the axis of the dam (North-South direction). The depth of wall below ground surface is unknown. At the south end of this wall a section about 12.5 feet wide and 4.8 feet high has been removed, probably to provide access to small boats; this opening acts as an auxiliary spillway. The sill of this auxiliary spillway is concrete. Discharges from the spillway will flow along the abutment into the downstream channel. The left abutment is in natural ground.

It is reported that there are 18-inch and 24-inch diameter reservoir drains located at the right and left spillway training walls, respectively. Discharges from the 18-inch conduit are controlled by a manually operated gate valve located at the upstream face of the dam. The type of control for the 24 inch outlet pipe is unknown. The inlet and outlet elevations of both pipes are unknown. The discharges from both outlets flow into the downstream spillway channel.

b. Location

The dam is located at the south end of Beaver Dam Lake, about 900 feet north of the junction of Lake Road and State Route 94, and north of Salisbury Mills in Orange County, New York.

c. Size Classification

The dam is 35 feet high and has a storage capacity of 1440 acre-feet and is therefore classified as an intermediate dam (between 1,000 and 50,000 acre-feet).

d. Hazard Classification

The dam is in the "high" hazard potential category because the town of Salisbury Mills, including several homes and a state highway, is about 500 feet downstream from the dam.

e. Ownership

The Beaver Dam Lake is owned by the County of Orange, Goshen, New York, 10924, telephone 914-294-7951. It is reported that the dam and reservoir was acquired from the Beaver Lake Association because of tax default.

f. Purpose of Dam

The impoundment provided by the dam is used for recreational purposes.

g. Design and Construction History

The original design and construction records are not available. The exact date of the construction of the dam and contractor's name are unknown.

h. Normal Operational Procedures

Lake level is maintained at the crest of the right spillway section, depending upon the inflow into the lake. At present, outflow from the lake is over the ungated spillway only. The two reservoir drains are not in operating condition and reportedly have not been used for several years.

1.3 PERTINENT DATA

- a. Drainage Area, square miles 9.25
- b. Discharge at Dam, cfs
Maximum known flood at site Unknown
Ungated Spillway at Maximum Pool 3910
Ungated Auxiliary Spillway at Max. Pool 750
Regulating Outlets at Maximum Pool
18 Inch Diameter Pipe Inoperable
24 Inch Diameter Pipe Inoperable
- c. Elevation (feet above MSL)
Top of Dam, feet 338.0
Spillway, feet 331.0
Auxiliary Spillway, feet 333.3
Streambed at Centerline of Dam Unknown
- d. Reservoir
Length of Normal Pool, feet 4200
Surface Area of Maximum Pool, acres 183.3
Surface Area of Normal Pool, acres 164.0
- e. Storage, acre-feet
Spillway Crest 1440
Top of Dam 2644
- f. Dam
Type: Concrete wall with Earth Buttress
Length: 335 feet + (140 feet left section and 195 feet right section)
Height: 35 feet +
Crest Width: Varies between 3.5 feet and 3.75 feet (concrete wall)
Side Slopes: Upstream: Vertical and 9.6V : 1H
Downstream: Vertical 1V : 1.5H (left section) and 1V : 2H (right section)

g. Spillways

Principal Spillway:

Type: uncontrolled masonry and concrete spillway divided into two sections, 30.0 feet and 35 feet, by a stepped brick pier.

Auxiliary Spillway (opening in abutment wall):

Type: uncontrolled, 12.5 feet wide and 4.8 feet high, opening at right abutment wall. Crest width 4.0 feet.

h. Reservoir Drains

According to available documents the dam has two reservoir drains; an 18 inch and a 24 inch pipe, located at the inside face of the left and right training walls of the spillway, respectively. The drains have not been used for several years and are not in operating condition. The discharge through the 18 inch pipe is controlled by a manually operated gate valve located at the upstream face of the right training wall of the spillway. There exists no control for the 24 inch pipe.

SECTION 2 - ENGINEERING DATA

2.1 GEOLOGY

Beaver Dam is located in the Hudson Lowlands physiographic province of New York State. These lowland areas have gentle relief and are underlain by Ordovician shales that have been exposed by the erosion of overlying Silurian and Devonian limestones. Beaver Dam Lake lies principally in the black, Snake Hill shale of the Trenton Group. A reverse fault follows the northeast border of the lake, with the northern, upthrust block composed of undifferentiated carbonates of the Stockbridge Group. (Ref. 8).

2.2 SUBSURFACE INVESTIGATION

No subsurface investigation could be located for the project. However, surficial soils in the vicinity of the dam are of the Boynton-Albia Association (Refs. 9 and 10). These soils, found in the depressions and broad drainage channel areas of the Hudson Lowland province, are developed from till derived from slate and sandstone. The resistant sandstone persists as stones in the till.

The Boynton, making up 40 to 80% of the area, is commonly stony to very stony, deep to bedrock and poorly drained on a 0 to 3% slope. The Albia, from 0 to 50% of the area, is commonly stony, deep to bedrock, and somewhat poorly drained on a 0 to 8% slope. (Refs. 9 and 10).

2.3 DESIGN RECORDS

There are no design data, construction drawings or design memoranda available for the project features. A document dated 1912 was obtained from the New York Department of Environmental Conservation, and is given in Appendix B. The document has information regarding the dam and the spillway, and was used in determining the section of the spillway.

2.4 CONSTRUCTION RECORDS

Records of original construction are not available for the project.

2.5 OPERATION RECORDS

There are no records of operation of the dam. The regulating outlets at the dam have not been in operating condition for many years. There is no formal operation and maintenance manual for the project. No records of reservoir levels and rainfall have been kept.

2.6 EVALUATION OF DATA

Information was made available by the New York State Department of Environmental Conservation and the County of Orange, New York.

The information obtained from the available data, the personal interviews and the visual inspection is considered adequate for this Phase I inspection and evaluation.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General

A visual inspection of Beaver Dam Lake was made on Thursday, April 24, 1980. At the time of inspection, the reservoir level was about El 331.5, four inches above the crest of the right spillway section. Only a small quantity of flow was trickling over the left spillway section. The weather was sunny and temperature between 65° and 70° F.

b. Dam

The dam, which consists of a concrete wall and downstream earth buttress, appears to be in generally adequate condition. There are no visible signs of distress or movement. The alignment of the crest is good. The edge of the downstream crest is heavily spalled at several locations.

The upstream brick facing is in good condition above the water line except at several locations where the mortar at the joints is loose and missing. The downstream face of the wall is heavily spalled, particularly at the east wing of the dam (See Photograph 12).

Both wings of the downstream earth buttress are in good condition and show no signs of sloughing, erosion or cracking. At about 40 feet downstream of the left wing buttress there is a saturated area caused by seepage. The source of the seepage could not be determined (See Photograph 1). Both wings of buttress are covered with vegetation including large trees, bushes, sapling and grass. (See Photographs 3 and 4).

The loose stone on the downstream face is in satisfactory condition.

c. Spillway

Visual inspection of the right section of the spillway could not be carried out because of water flowing at the time. However, it was reported that the section is in generally good condition. The left section of the spillway is in satisfactory condition. There is minor seepage through the masonry joints of the stepped face of the spillway weir. There is some vegetation including a tree at the crest and the downstream face of the weir.

At several locations at the spillway training walls there are signs of serious deteriorations due to frost action. The bricks and mortar at the masonry joints, particularly at the right and the middle training walls, are loose and missing. There are few minor cracks at the right training wall.

The emergency spillway is in good condition.

d. Appurtenant Structures

The 18-inch reservoir drain at the right spillway training wall could not be located, however, its regulating gate is in poor condition. The gate stem is broken and frozen into the base of the hoist support. The upper portion of the hoist is non-existent. Only the downstream end of the 24-inch reservoir drain is visible; the gate hoist for this outlet could not be located and was reported to be non-existent.

e. Abutments

There are no signs of seepage or other unusual conditions at both abutments. At the right abutment natural ground downstream of the concrete wall appears to be eroded to a depth of 3 feet. This erosion could have been caused by past overtopping of the dam.

f. Downstream Channel

The channel downstream of the spillway is the natural streambed. Although the channel contains natural vegetation, including large trees, saplings, and grass, its present condition would not impede discharges from the spillway.

g. Reservoir Area

In the vicinity of the dam there is no evidence of sloughing, potentially unstable slopes or other unusual conditions which would adversely affect the dam. No evidence of excessive sedimentation was observed. The reservoir water was relatively clean.

3.2 EVALUATION OF OBSERVATIONS

Visual observations made during the course of the investigation reveal several deficiencies which should be corrected before further deterioration leads to a hazardous condition. The deficiencies are:

a. Both reservoir drains and its controls should be made operable.

b. Inspect on a bi-weekly interval to determine if seepage quantities are increasing through the joints at the downstream face of the spillway.

c. Determine the source of seepage occurring downstream of the east buttress toe. Monitor the seepage bi-weekly with the aid of weirs.

d. Spalled areas at the crest and the downstream face of the concrete wall should be repaired.

e. Loose and missing pointing at the upstream face of the dam and the spillway training walls should be repaired.

f. The right and the middle spillway training walls should be repaired.

g. The cracks at the right spillway training wall should be repaired.

h. The brush and trees should be removed from the crest and the downstream face of the left spillway section and from the crest, the slopes of the buttress, and the downstream toe area. Provide a program of periodic cutting and moving of the buttress surface.

i. A program of periodic inspections and maintenance of the dam and appurtenances, including yearly operation and lubrication of all gates should be established. This information should be documented for future reference. The emergency action plan described in Section 7.1d should be maintained and updated periodically during the life of the structure.

SECTION 4 - OPERATION AND MAINTENANCE PROCEDURES

4.1 PROCEDURES

There are no operating procedures for regulating the discharges. Flow is discharged over the ungated spillway. The lake is generally at the level of the spillway crest during most of the year.

The reservoir drains of the dam are inoperable and have not been operated for many years.

4.2 MAINTENANCE OF DAM AND SPILLWAYS

The presence of undesirable vegetation on the downstream face of the dam and at the spillway, inoperative reservoir drains and deterioration of spillway training walls and concrete wall of the dam indicates that no regular maintenance has been performed for many years. This was also reported by Mr. Dougherty, representative of the owner. According to available records at the New York State Department of Environmental Conservation, the dam was inspected in 1973 and 1978.

4.3 WARNING SYSTEM IN EFFECT

There is no warning system in effect or in preparation.

4.4 EVALUATION

The overall maintenance of the Beaver Dam Lake is considered to be inadequate with respect to the following areas:

- a. Control of vegetation on the buttress of the dam and at the spillway.
- b. Maintenance of the spillway training walls and the concrete wall of the dam.
- c. Maintenance of the regulating gates and reservoir drains.

SECTION 5 - HYDROLOGIC/HYDRAULIC

5.1 DRAINAGE AREA CHARACTERISTICS

Beaver Dam Lake is located north of Salisbury Mills in Orange County, New York. (Hydrologic Unit Code 02020008). The total drainage area contributing to the lake is about 9.25 square miles, with a reservoir surface area of about 164 acres at El 331. The drainage basin length to width ratio is approximately 5 to 1, with fairly steep slopes rising from lake El 331 to ridges above El 600.

5.2 ANALYSIS CRITERIA

The analysis of the spillway capacity of this dam was performed using the Corps of Engineers HEC-1 computer program for Dam Safety Investigations (Ref. 1). The Snyder's coefficients of 2.11 and 320 for C_t and 640 C_p , respectively, were obtained from a report on the Lower Hudson River Basin (Ref. 2). The Probable Maximum Precipitation (PMP) was taken from Hydrometeorological Report No. 51, "Probable Maximum Precipitation Estimates, U.S. East of the 105th Meridian", (Ref. 4). In accordance with the recommended guidelines (Ref. 7), the adequacy of the spillway was analyzed using the Probable Maximum Flood (PMF).

5.3 SPILLWAY CAPACITY

The principal masonry and concrete spillway is an ungated 65 foot long structure and is divided into 30 and 35 foot sections by an 8 foot wide stepped brick pier. The depth from the top of dam to the crest of both sections is about 7 feet. The sill of both sections is about 6 feet wide. Downstream portion of the spillway is a stepped concrete apron chute about 30 feet long.

The computed maximum spillway discharge at El 338 (top of dam) is 3910 cfs. The two reservoir drains are inoperable.

5.4 RESERVOIR CAPACITY

The normal storage capacity of Beaver Dam Lake is listed as 1440 acre-feet (Ref. 5). The surcharge storage between the spillway crest, El 331, and top of dam, El 338, is 1204 acre-feet which is equivalent to 2.44 inches of runoff over the entire basin. The total or maximum capacity of the lake at El 338 is 2644 acre-feet.

5.5 FLOODS OF RECORD

There are no records available of floods or maximum lake elevations.

5.6 OVERTOPPING POTENTIAL

The potential of the dam being overtopped was investigated on the basis of the spillway discharge capacity and the available surcharge storage to meet the selected design flood inflows.

The Probable Maximum Flood (PMP) routed through the lake causes the lake surface to rise to El 340.5, 2.5 feet above the top of the dam. The computed PMF peak inflow and outflow discharges were 10,600 cfs and 10,395 cfs, respectively. The one-half Probable Maximum Flood routed through the lake caused the lake surface to rise to El 338.50, 0.50 feet above top of the dam. The peak outflow discharge was 4765 cfs.

Using the Corps of Engineers Criteria the maximum spillway capacity without overtopping the dam is 37 percent of PMF peak outflow.

5.7 EVALUATION

The dam does not have sufficient spillway capacity to pass either the PMF or one-half the PMF without overtopping the dam. The overtopping could cause the failure of the dam thus significantly increasing the hazard to the loss of life downstream. Therefore, the spillway is assessed as being "seriously inadequate".

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations

Visual observations did not indicate either existing or potential problems with the dam and the spillway structures. The observed seepage downstream of the left buttress toe and at the spillway; and deterioration of the spillway training walls are not considered to represent an unstable or otherwise dangerous condition.

b. Design and Construction Data

There exists no design computation or other data regarding the structural stability of the dam and the spillway. There is a document dated 1912 (See Appendix B) which shows the section of the dam, plan and section of spillway.

c. Stability Analysis

Since there are no contract drawings or documents available showing the full geometry, the extent of the spillway section, and the foundation conditions, the primary source of structural and subsurface information used in the stability analysis is as follows:

1. The downstream surface geometry of the exposed spillway structure was measured during the inspection using approximate methods (See sketch of spillway section given in Appendix A).

2. The other geometry of non-exposed spillway structure and subsurface information was obtained from the documents described in Paragraph 6.1b.

The following table shows the results of the structural stability analysis of the spillway section. The computations for the stability analysis are given in Appendix F

		Sliding Factor of Safety (See Appendix F)
<u>Case</u>		
a.	Normal Loading with reservoir level at spillway crest; no ice load	1.35
b.	Normal Loading with reservoir level at Spillway Crest with ice load	1.13
c.	Unusual Loading; water flowing over the spillway at depth of 7.5 feet (one-half PMF)	0.69
d.	Extreme Loading; water flowing over the spillway at depth of 9.5 feet (PMF)	0.57

	<u>Case</u> <u>Overturning</u>	<u>Sliding Factor</u> <u>of Safety</u> (See Appendix F)
e. Normal Loading, case a with earthquake	Inside middle half of base	1.13

The results of the structural analysis indicates that the spillway section against overturning is inadequate for all cases except for case a and e. Also, the sliding stability is inadequate for all loading cases.

Since there is a lack of information regarding the exact geometry of the dam, foundation conditions and the extent and magnitude of the uplift pressure under the spillway, the structural stability of the spillway could not be accurately assessed with any reliability. It is, therefore, recommended that, along with the spillway adequacy studies, a more detailed structural stability analysis be performed. Field investigations should be carried out to obtain additional information regarding the uplift pressure within and under the base of the spillway; the quality of the foundation; the geometry and extent of the spillway structure; and the condition of the non-exposed masonry and concrete. The information should then be incorporated into a more detailed structural stability evaluation.

d. Operation Records

There are no records of the regulating gate operation.

e. Post-Construction Changes

There are no recorded post-construction changes.

f. Seismic Stability

The dam is located in the Seismic Zone 1 in accordance with Phase I recommended guidelines. However, based on the past earthquake experiences in the area, the New York State Geological Survey considers the area to be in the Seismic Zone 2. Based on this assessment the dam is considered in the Seismic Zone 2. The results of seismic stability are described in Section 6.1c.

SECTION 7 - ASSESSMENT/RECOMMENDATIONS

7.1 ASSESSMENT

a. Safety

Examination of the available documents and visual inspections of the Beaver Dam Lake and appurtenant structures did not reveal any conditions which are considered to be hazardous.

Using the Corps of Engineers screening criteria for review of spillway adequacy, it has been determined that the dam would be overtopped for all storms exceeding approximately 37 percent of the PMF. The overtopping of the dam could cause the erosion of the downstream face of the dam resulting in dam failure, increasing the hazard to loss of life downstream. The spillway is, therefore, adjudged as "seriously inadequate" and the dam is assessed as unsafe, non-emergency.

The classification of "unsafe", applied to a dam because of a "seriously inadequate spillway", is not meant to connote the same degree of emergency as would be associated with an "unsafe" classification applied for a structural deficiency. It does mean, however, that based on an initial screening, and preliminary computations, there appears to be a serious deficiency in spillway capacity so that if a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard to loss of life downstream from the dam.

d. Adequacy of Information

The information and data available were adequate for performance of this investigation, except as noted in Section 6.1c.

c. Need for Additional Investigations

Since the spillway is considered to be "seriously inadequate", additional hydrologic/hydraulic investigations are required to more accurately determine the site specific characteristics of the watershed. After the in-depth hydrologic/hydraulic investigations have been completed, remedial measures must be initiated to provide spillway capacity sufficient to discharge the outflow from the 1/2 PMF event. In addition, an investigation of the structural stability of the spillway portion of the dam is required.

d. Urgency

The additional hydrologic/hydraulic investigations and the stability investigation which are required must be initiated within 3 months from the date of notification. Within 1 year of notification, remedial measures as a result of these investigations must be initiated, with completion of these measures during the following year. In the interim, develop an emergency action plan for the notification of downstream residents and proper governmental authorities in the event of overtopping, and provide round-the-clock surveillance of the dam during periods of extreme run-off. The other problem areas listed below must be corrected within 1 year from notification.

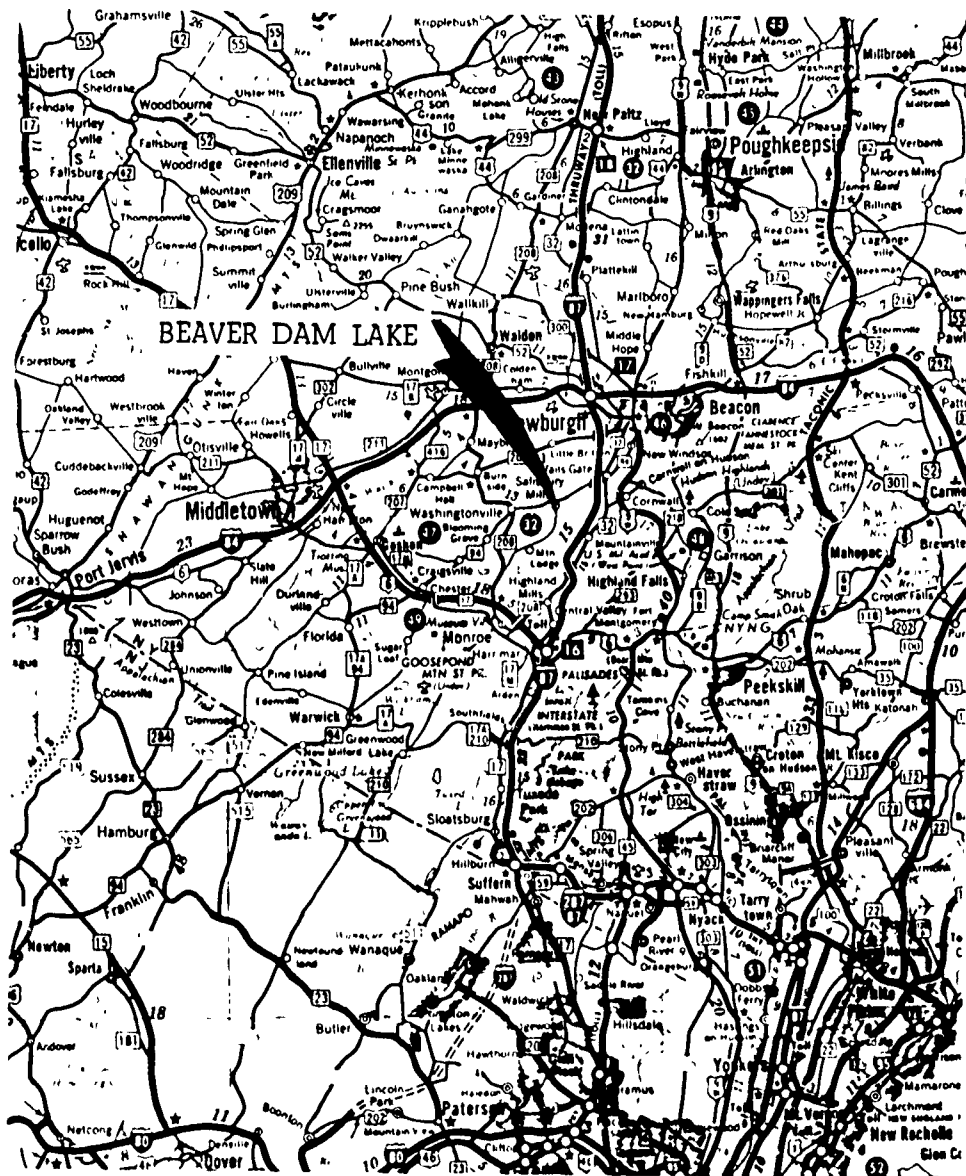
7.2 RECOMMENDED MEASURES

The following are the recommended measures:

- a. Both the reservoir drains and its controls should be made operable.
- b. Monitor, bi-weekly, to determine if seepage quantities are increasing through the joints at the downstream face of the spillway.
- c. Determine the source of seepage occurring downstream of the east buttress toe. Monitor the seepage bi-weekly with the aid of weirs.
- d. Spalled areas at the crest and the downstream face of the wall should be repaired.
- e. Loose and missing pointing at the upstream face of the dam and the spillway training walls should be repaired.
- f. The right and middle training walls should be repaired.
- g. The cracks at the right spillway training wall should be repaired.
- h. The brush and trees should be removed from the crest and the downstream face of the left spillway section and the slopes of the buttress and the downstream toe area. Provide a program of periodic cutting and mowing of the buttress surface.
- i. A program of periodic inspections and maintenance of the dam and appurtenances, including yearly operation and lubrication of all gates should be established. This information should be documented for future reference. The emergency action plan described in Section 7.1d should be maintained and updated periodically during the life of the structure.

DRAWINGS

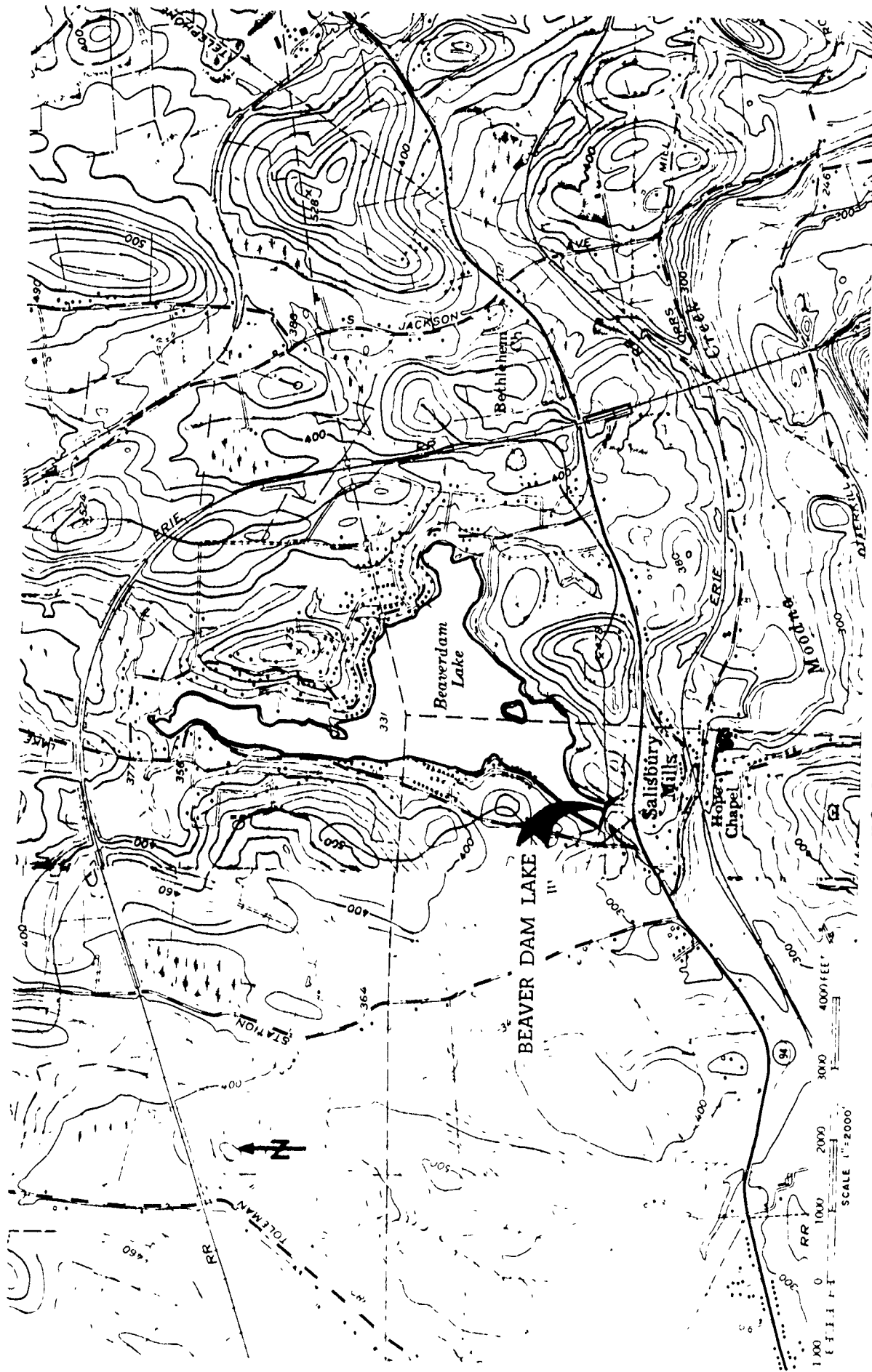
APPENDIX A



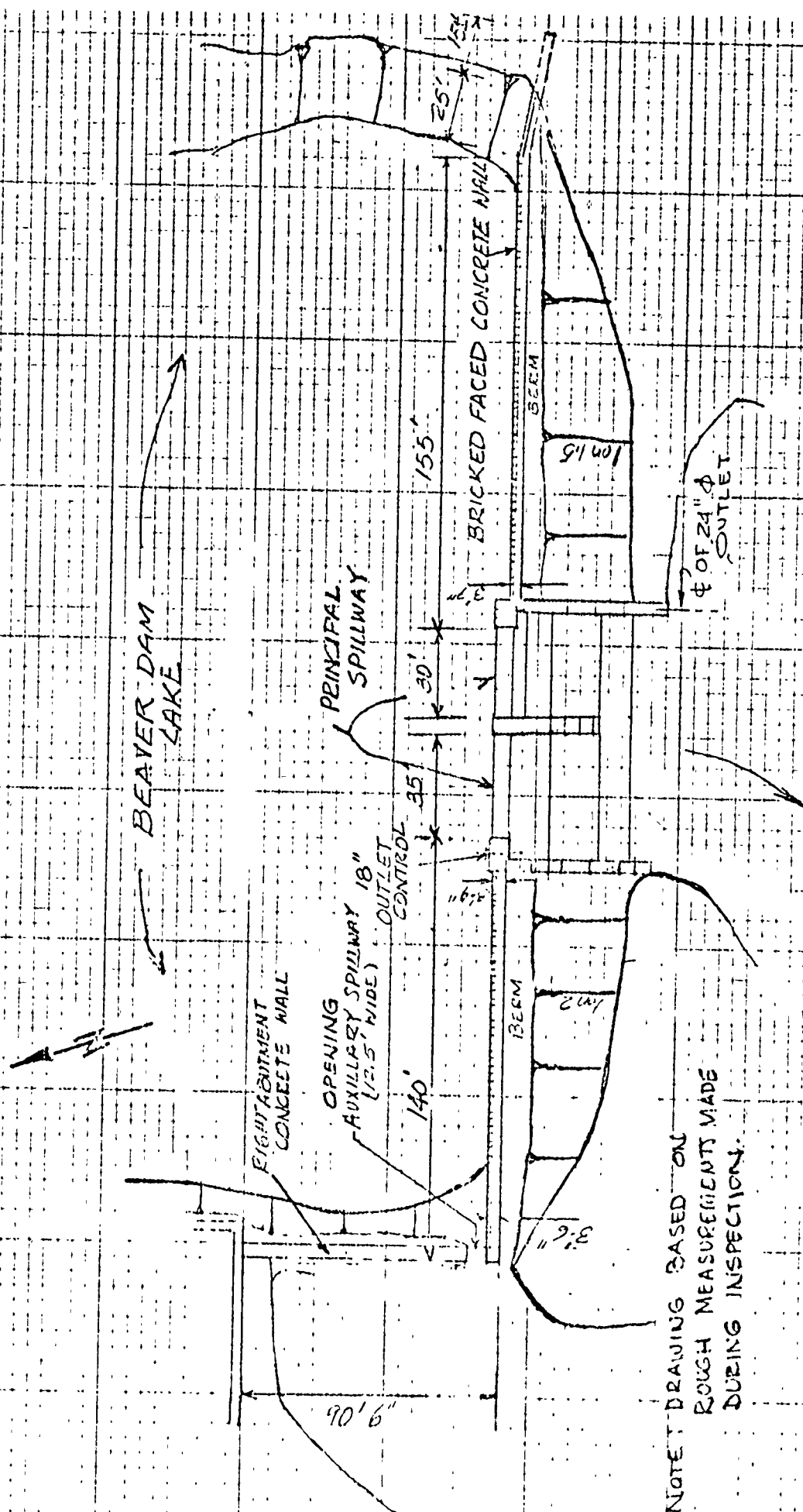
SCALE 1 inch = 11.2 Miles

VICINITY MAP
BEAVER DAM LAKE

MAYBROOK AND CORNWALL QUADS.
NEW YORK



TOPOGRAPHIC MAP
BEAVER DAM LAKE



NOTE: DRAWING BASED ON
ROUGH MEASUREMENTS MADE
DURING INSPECTION.

BEAVER DAM LAKE - PLAN
SCALE 1" = 50'

NOTES:

1. Dimension are based on rough measurements during inspection.
2. Depth and configuration below water line are assumed based on an available document dated 1912.

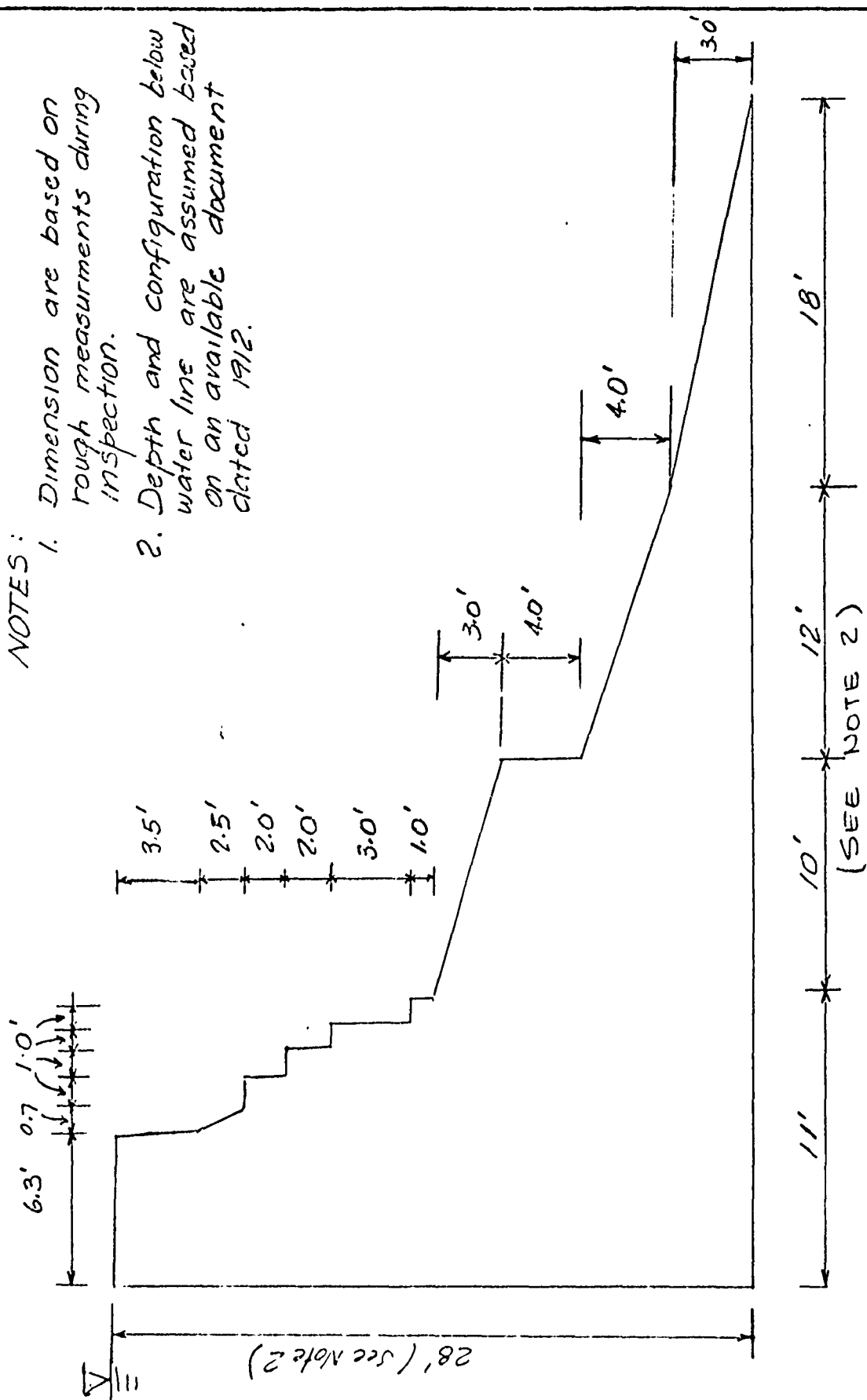
Dimensions (feet):

- Top left horizontal segments: 6.3', 0.7', 1.0'
- Vertical segments (from left to right): 3.5', 2.5', 2.0', 2.0', 3.0', 1.0'
- Horizontal segments (from left to right): 3.0', 4.0', 4.0', 3.0'
- Bottom horizontal segments (from left to right): 11', 10', 12', 18'
- Right vertical segment: 3.0'

Additional notes:

- 28' (see Note 2) - dimension across the bottom of the structure.
- (SEE NOTE 2) - reference to the bottom right dimension.

1. Dimension are based on rough measurements during inspection.
2. Depth and configuration below water line are assumed based on an available document dated 1912.



SECTION - RIGHT SPILLWAY SECTION

NYS DEPT. OF ENVR. & CONS.

TIPPETTS-ABBETT-McCARTHY-STRATTON
ENGINEERS and ARCHITECTS NEW YORK

PHASE I INSPECTION

SPILLWAY -- SECTION

BY JP	DATE 5/3
-------	----------

DRAWING NUMBER

1912 DOCUMENT

APPENDIX B

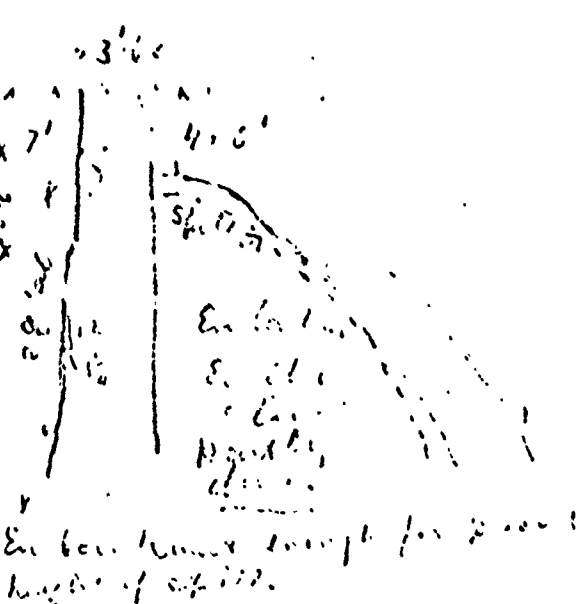
Fill out a form as complete as possible for each dam in your district and send to State Conservation Commission, Albany, N. Y.

1. Name and address of owners H Powell Ramsdell, Newburgh
2. Date of construction 1861
3. Uses of impounded water Dec.
4. Character of foundation bed Hard pan
5. Material of waste spill Rubble masonry
6. Length of waste and depth below dam Run 35' x 7' one 35' x 7' ditch
7. Total length of dam including waste 336'
8. Material of dam Rubble masonry. Arched faced with brick
9. Discharges, size and location 24" and 18" at base

Below sketch section of waste and section of dam, with greatest heights and top thickness and bottom thickness. On opposite side sketch general plan of dam and give distance from a bridge or from a tributary stream.

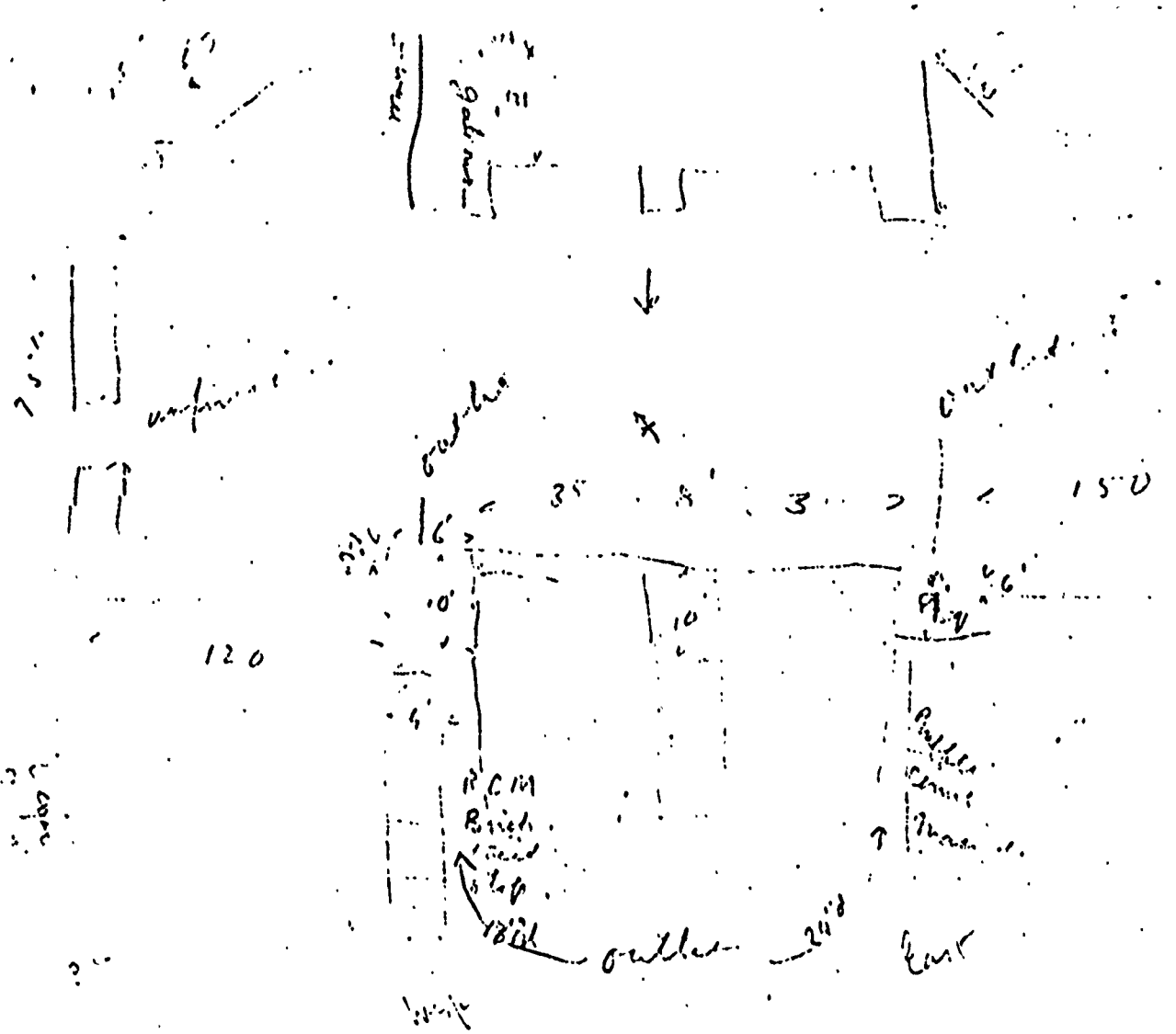
Nearest town

Salisbury

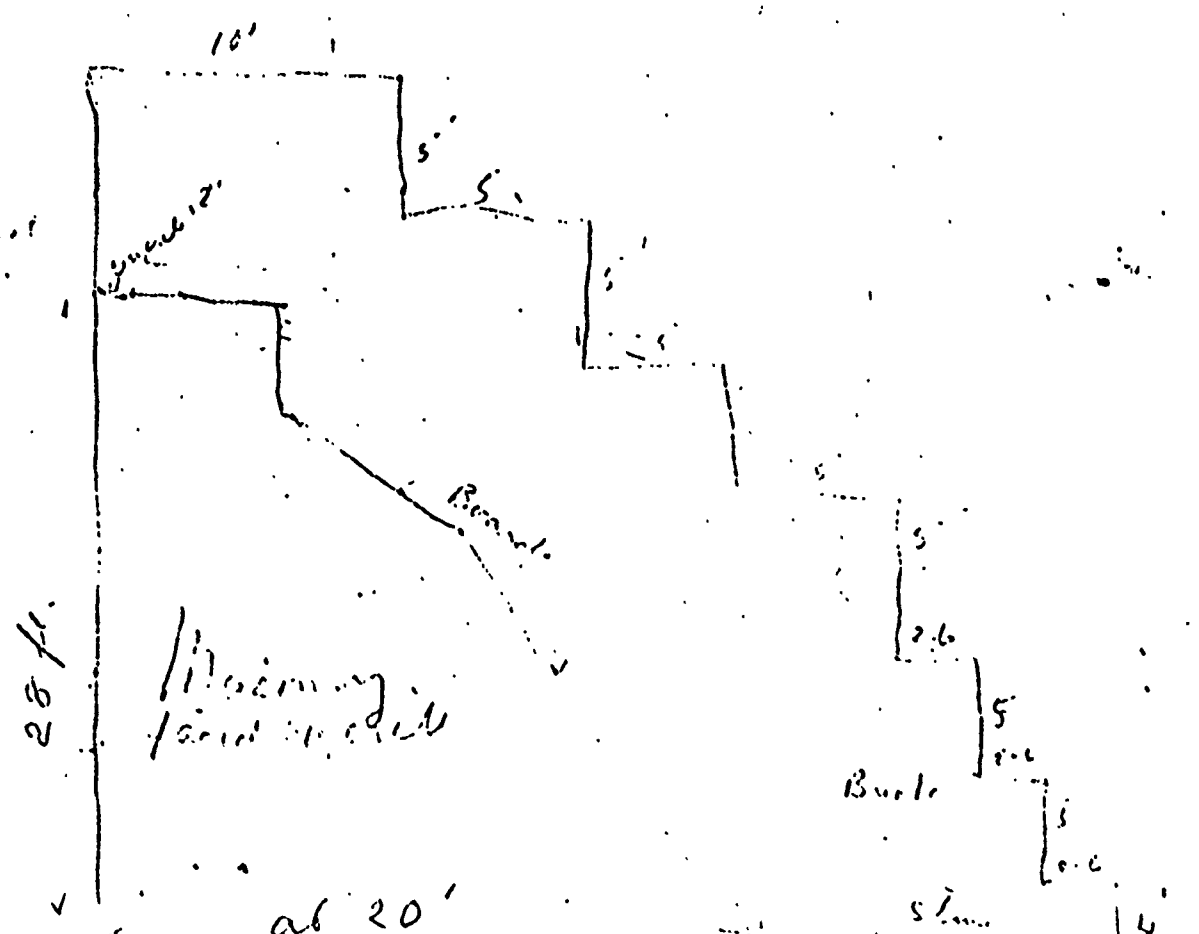


spill, several small
on down side. structure

Dec 23 1912
Oct 24 1912
A R Ramsdell
(Signature, address and date.)



18" post highest
above water.



PHOTOGRAPHS

APPENDIX C



LOOKING
RIGHT

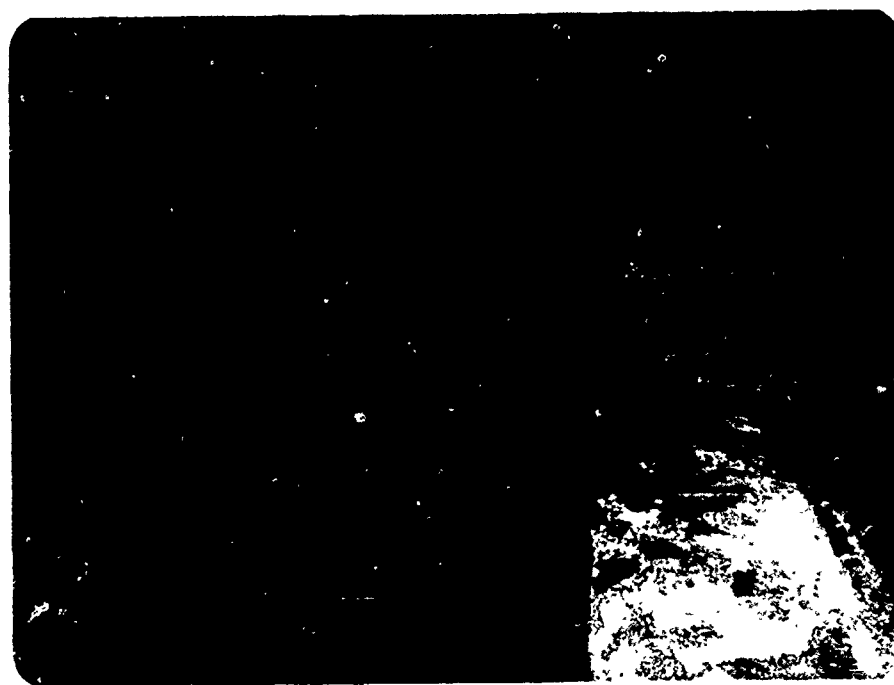


LOOKING
LEFT

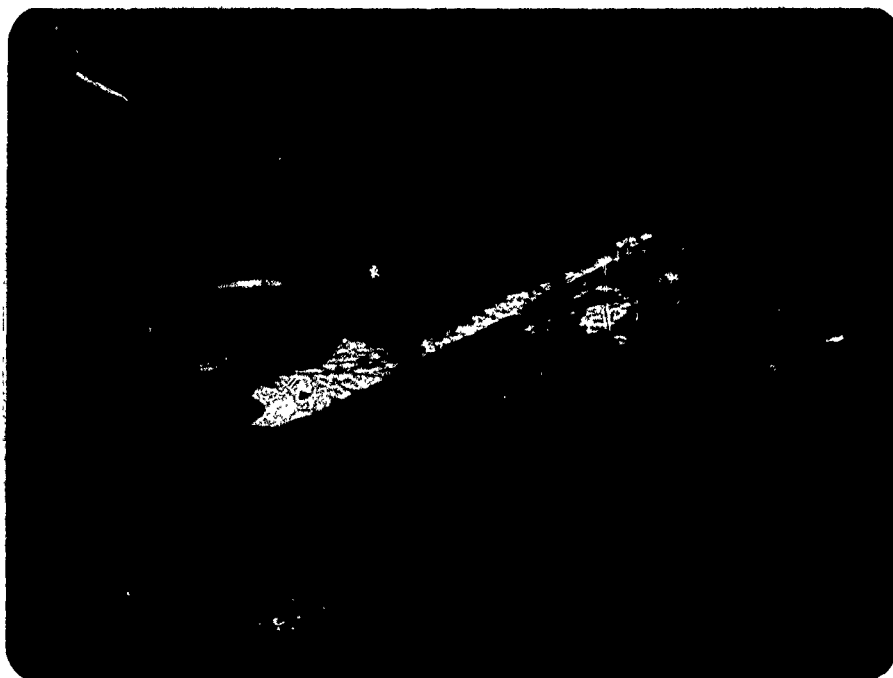
2. VIEWS OF UPSTREAM FACE OF DAM.



3. VIEW OF DOWNSTREAM FACE (LEFT SECTION) OF DAM.
NOTE VEGETATION AT SLOPE AND SPILLWAY.



4. VIEW OF CREST AND DOWNSTREAM FACE (RIGHT SECTION)
OF DAM. NOTE VEGETATION AT SLOPE.



5. VIEW OF DOWNSTREAM SPILLWAY CHANNEL. NOTE VEGETATION.



6. VIEW OF WALL AT RIGHT ABUTMENT. NOTE OPENING IN THE WALL WHICH SERVES AS AUXILIARY SPILLWAY.



7. VIEW OF DOWNSTREAM FACE OF SPILLWAY (LEFT SECTION). NOTE 24-INCH RESERVOIR DRAIN AND MINOR VEGETATION AT MIDDLE PIER.



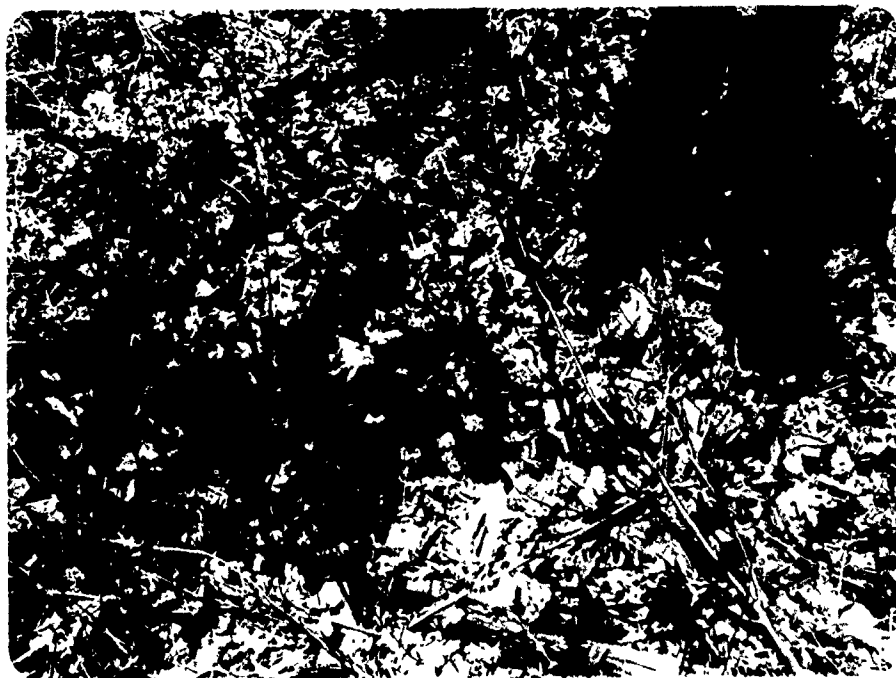
8. VIEW OF UPPER PORTION OF THE DOWNSTREAM FACE AND LEFT BRICK PIER OF SPILLWAY. NOTE VEGETATION AND CONDITION OF MASONRY.



9. VIEW OF REGULATING CONTROL FOR
18-INCH RESERVOIR DRAIN.



10. VIEW OF DOWNSTREAM FACE OF RIGHT
ABUTMENT CONCRETE WALL. NOTE
EROSION OF GROUND DUE TO OVER-
TOPPING OF DAM IN PAST.



11. VIEW OF SEEPAGE AT DOWNSTREAM FROM THE TOE OF DAM (LEFT SECTION).



12. VIEW OF DOWNSTREAM FACE (LEFT SECTION) OF DAM. NOTE DETERIORATION OF CONCRETE.

VISUAL INSPECTION CHECKLIST

APPENDIX D

VISUAL INSPECTION CHECKLIST

1) Basic Data

a. General

Name of Dam BEAVER DAM LAKE

Fed. I.D. # 619 DEC Dam No. 502

River Basin HUDSON

Location: Town SALISBURY MILLS County ORANGE

Stream Name MOODNA CREEK

Tributary of HUDSON RIVER

Latitude (N) 41° 26' Longitude (W) 74° 07' 30"

Type of Dam MASONRY FACE CONCRETE AND EARTH FILL BUTTRESS

Hazard Category HIGH

Date(s) of Inspection 4-23-80

Weather Conditions SUNNY 70°F

Reservoir Level at Time of Inspection 331.5

b. Inspection Personnel TONY DOLCIMASCOLO AND JYOTINDRA PATEL

c. Persons Contacted (Including Address & Phone No.)

MR. ROBERT DOUGHERTY, PRINCIPAL ENGINEER

DEPT OF PUBLIC WORKS, ORANGE COUNTY, P.O. BOX 507,

GOSHEN NEW YORK 10924.

TEL NO. (914) 294-7951

d. History:

Date Constructed UNKNOWN **

Date(s) Reconstructed —

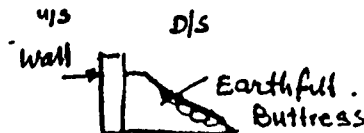
Designer UNKNOWN

Constructed By UNKNOWN

Owner UNKNOWN

** From Available records (see Appendix) of 1912-1913 indicates it is constructed before these dates.

2) Embankment — DOWNSTREAM OF CONCRETE WALL



a. Characteristics

- (1) Embankment Material _____

(2) Cutoff Type _____ NONE _____

(3) Impervious Core _____ NONE _____

(4) Internal Drainage System _____ NONE _____

(5) Miscellaneous _____

b. Crest IS TOP OF CONCRETE WALL WITH BRICK MASONRY
AT UPSTREAM FACE

- (1) Vertical Alignment _____ (SEE STRUCTURAL COMMENTS.) _____

(2) Horizontal Alignment _____

(3) Surface Cracks _____

(4) Miscellaneous _____

c. Upstream Slope —

- (1) Slope (Estimate) (V:H) _____
(2) Undesirable Growth or Debris, Animal Burrows _____

(3) Sloughing, Subsidence or Depressions _____

(4) Slope Protection _____

(5) Surface Cracks or Movement at Toe _____

d. Downstream Slope

(1) Slope (Estimate - V:H) 1(V):2(H) ON RIGHT WING AND 1(V):1.5(H) LEFT WING.

(2) Undesirable Growth or Debris, Animal Burrows COMPLETELY COVERED WITH VEGETATION INCLUDING LARGE TREES, SAPPLINGS, BUSHES AND GRASS. ONE BURROW AT LEFT BUTTRESS

(3) Sloughing, Subsidence or Depressions NONE OBSERVED

(4) Surface Cracks or Movement at Toe NONE OBSERVED

(5) Seepage NONE OBSERVED (SEE No 6)

(6) External Drainage System (Ditches, Trenches; Blanket) _____
NONE

(7) Condition Around Outlet Structure NO OUTLET STRUCTURE HOWEVER BOTH EMBANKMENTS CONTACT WITH SPILLWAY TRAINING WALL.

(8) Seepage Beyond Toe AT 40 FT DOWNSTREAM OF THE LEFT WING TOE, A SEEPAGE NOTED. SATURATED AREA ABOUT 40' X 20'. NONE OBSERVED AT THE WEST WING.

e. Abutments - Embankment Contact

LEFT ABUTMENT - NATURAL GROUND.

RIGHT ABUTMENT - NATURAL GROUND RETAINED BY CONCRETE WALL

(1) Erosion at Contact NONE OBSERVED.

(2) Seepage Along Contact NONE OBSERVED.

3) Drainage System — NONE

a. Description of System _____

b. Condition of System _____

c. Discharge from Drainage System _____

4) Instrumentation (Monumentation/Surveys, Observation Wells, Weirs, Piezometers, Etc.) _____

NONE

5) Reservoir

- a. Slopes VISIBILE SLOPES IN VICINITY OF DAM ARE IN
GENERALLY STABLE CONDITION
- b. Sedimentation NO EVIDENCE OF EXCESSIVE SEDIMENTATION
OBSERVED. LAKE WATER RELATIVELY CLEAR.
- c. Unusual Conditions Which Affect Dam NONE

6) Area Downstream of Dam

- a. Downstream Hazard (No. of Homes, Highways, etc.) TOWN OF SALISBURY
MILLS, AND ST. RT 94. (ABOUT 500 FT FROM DAM
- b. Seepage, Unusual Growth NONE OTHER OBSERVED EXCEPT
AS NOTE IN PAR. # 2d EMBANKMENT-SEEPAGE
- c. Evidence of Movement Beyond Toe of Dam NONE OBSERVED
- d. Condition of Downstream Channel ^{*} GOOD; SEVERAL LARGE TREES, HOWEVER
WILL NOT IMPEDE DISCHARGE. MINOR DEBRIS.

7) Spillway(s) (Including Discharge Conveyance Channel)

PRINCIPAL
CONCRETE & MASONRY SPILLWAY. CREST LENGTHS LEFT & RIGHT SECTIONS ARE ABOUT
30 & 35 FEET RESPECTIVELY. AT RIGHT ABUTMENT ABOUT 12.5' WIDE OPENING
IN THE CONCRETE WALL, WHICH WILL ACT AS AN AUXILIARY SPILLWAY.

- a. General SPILLWAY CROSS SECTION IS STEPPED. AT TIME OF
INSPECTION ABOUT 4" OF WATER WAS FLOWING OVER
RIGHT SPILLWAY. LEFT SPILLWAY TRICKLING. PRINCIPAL
& EMERGENCY SPILLWAY ARE UNCONTROLLED
- b. Condition of Service Spillway CONDITION OF RIGHT SPILLWAY
COULD NOT BE DETERMINED BECAUSE OF DISCHARGES FLOWING
OVER IT. LEFT SPILLWAY IS IN SATISFACTORY CONDITION. AT CREST &
DOWNSTREAM FACE OF WEIR SOME VEGETATION INCLUDING
A SMALL TREE AT THE CONTACT BETWEEN THE CREST & LEFT SPILLWAY
TRAINING WALL; MINOR SEEPAGE FROM THE MASONRY JOINTS.

* ALSO SPILLWAY CHANNEL

c. Condition of Auxiliary Spillway Good.

d. Condition of Discharge Conveyance Channel

GOOD. THERE ARE SEVERAL LARGE TREES, HOWEVER,
WILL NOT IMPROVE DISCHARGE. EMERGENCY SPILLWAY CHANNEL
IN GOOD CONDITION, EXCEPT LARGE TREES.

8) Reservoir Drain/Outlet ACCORDING TO AN AVAILABLE DOCUMENT (SEE APPENDIX) 18" ϕ
AND 24" ϕ OUTLET PIPE LOCATED AT EAST AND WEST SPILLWAY
WALLS.

Type: Pipe ☒ Conduit _____ Other _____

Material: Concrete ☒ Metal _____ Other _____

Size: 18" ϕ & 24" ϕ ** Lengths Unknown

Invert Elevations: Entrance Unknown Exit Unknown

Physical Condition (Describe): _____ Unobservable ☒ **

Material: _____

Joints: _____ Alignment _____

Structural Integrity: _____

Hydraulic Capability: CONTROL OF 24" ϕ PIPE NOT EVIDENT.
OWNER DOES NOT HAVE THE OPERATING MECHANISM, THEREFORE CONDITION
COULD NOT BE DETERMINED (18" ϕ) (SEE COMMENTS SECTION).

Means of Control: Gate _____ Valve ☒ Uncontrolled _____
(FOR 18" ϕ)

Operation: Operable _____ Inoperable ☒ Other _____

Present Condition (Describe): VISIBLE PORTION ABOVE GROUND LINE
(18" ϕ) IN FAIR CONDITION. MINOR EXISTING.

** LOCATION OF OUTLET END OF 24" PIPE COULD BE DETERMINED; LOCATION
OF OUTLET END OF 18" PIPE COULD NOT BE DETERMINED

9) Structural — DAM AND SPILLWAY.

- a. Concrete ^{AND MASONRY} Surfaces THE BRICK MASONRY OF THE DAM IN GENERALLY
GOOD CONDITION; MINOR CRACKS AND LOOSE MORTAR AT JOINTS. THE
CONCRETE PORTION (DOWNSTREAM FACE) HEAVILY SPALLED PARTICULARLY
AT THE LEFT SIDE OF THE DAM. SOME MINOR CRACKS OBSERVED. SPILLWAY
IN SATISFACTORY CONDITION. (SEE COMMENTS BELOW **)
- b. Structural Cracking NO SIGNIFICANT STRUCTURAL CRACKING
VISIBLE ON THE DAM'S WALL. MINOR CRACKING AT THE UPSTREAM
FACE OF LEFT TRAINING WALL.
- c. Movement - Horizontal & Vertical Alignment (Settlement) NONE
OBSERVED
- d. Junctions with Abutments or Embankments GOOD CONDITION.
- e. Drains - Foundation, Joint, Face NO DRAINS
- f. Water Passages, Conduits, Sluices SPILLWAY IS OVERFLOW TYPE.
THE CONDITION OF RESERVOIR DRAIN COULD NOT BE
DETERMINED
- g. Seepage or Leakage NONE OBSERVED

** THE TOP OF THE SPILLWAY WALLS ARE SERIOUSLY DETERIORATED.

- h. Joints - Construction, etc. SPALLING OF CONCRETE AT CONSTRUCTION JOINTS. OTHERWISE TIGHT.
- i. Foundation FOUNDATION NOT VISIBLE. HOWEVER FROM AN AVAILABLE RECORD THE DAM IS FOUNDED ON GLACIAL TILL (HARD PAN) SEE APPENDIX.
- j. Abutments RIGHT ABUTMENT DOWNSTREAM FACE CONCRETE WALL IS HEAVILY SPALLED.
- k. Control Gates NO CONTROL GATES AT THE SPILLWAYS
- l. Approach & Outlet Channels NONE
- m. Energy Dissipators (Plunge Pool, etc.) —
- n. Intake Structures NONE
- o. Stability THERE ARE NO VISUAL INDICATIONS THAT SPILLWAY SHOWS ANY EVIDENCE OF STABILITY PROBLEMS
- p. Miscellaneous EROSION OF FILL AT DOWNSTREAM FACE OF RIGHT ABUTMENT WALL INDICATES THAT DAM WAS OVERTOPPED. (SEE PHOTOGRAPH NO 10)

HYDROLOGIC DATA AND COMPUTATIONS

APPENDIX E

TAMS

Job No. 1551-07

Sheet 1 of 5

Project BEAVER DAM PHASE 1 INSPECTION

Date MAY 19 1980

Subject HYDROLOGIC / HYDRAULIC COMPUTATION

By DLC

Ch'k. by _____

DRAINAGE BASIN AREA

2.98 SQ MI

1907.2 ACRES

LAKE AREA

0.16 SQ MI

104.8 SQ MI

INDEX RAINFALL

INCHES

24 HR 200 SQ MI

24.5"

6 HR 10 SQ MI

26

106.1 %

12 HR 10 SQ MI

30

122.4 %

24 HR " "

33

134.7 %

48 HR " "

37

151.0 %

TAMS

Job No. 1551-07

Sheet 2 of 5

Project BEAVER DAM PHASE I INSPECTION

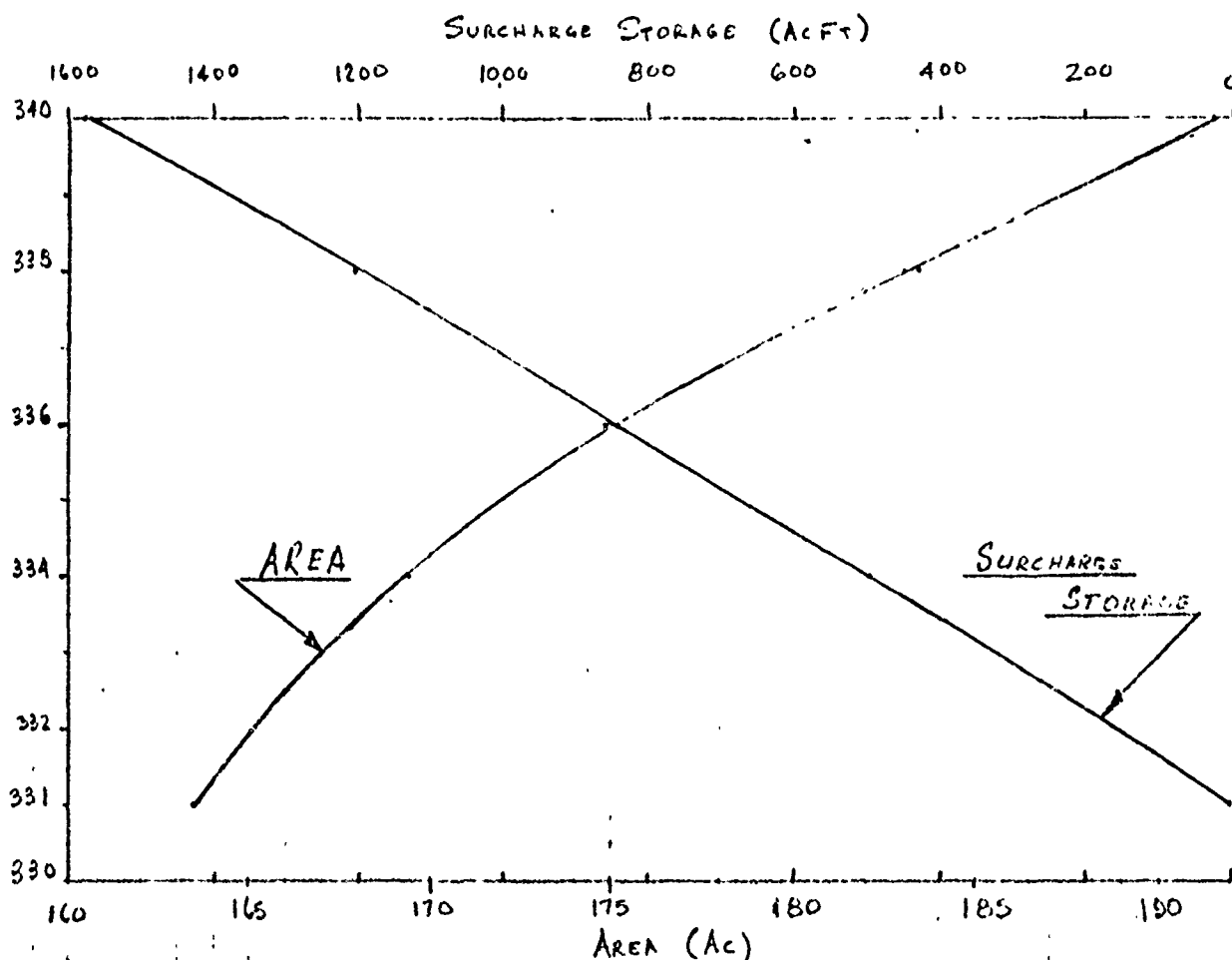
Date MAY 1 1980

Subject HYDROLOGIC / HYDRAULIC COMPUTATIONS

By DLC.

Ch'k. by _____

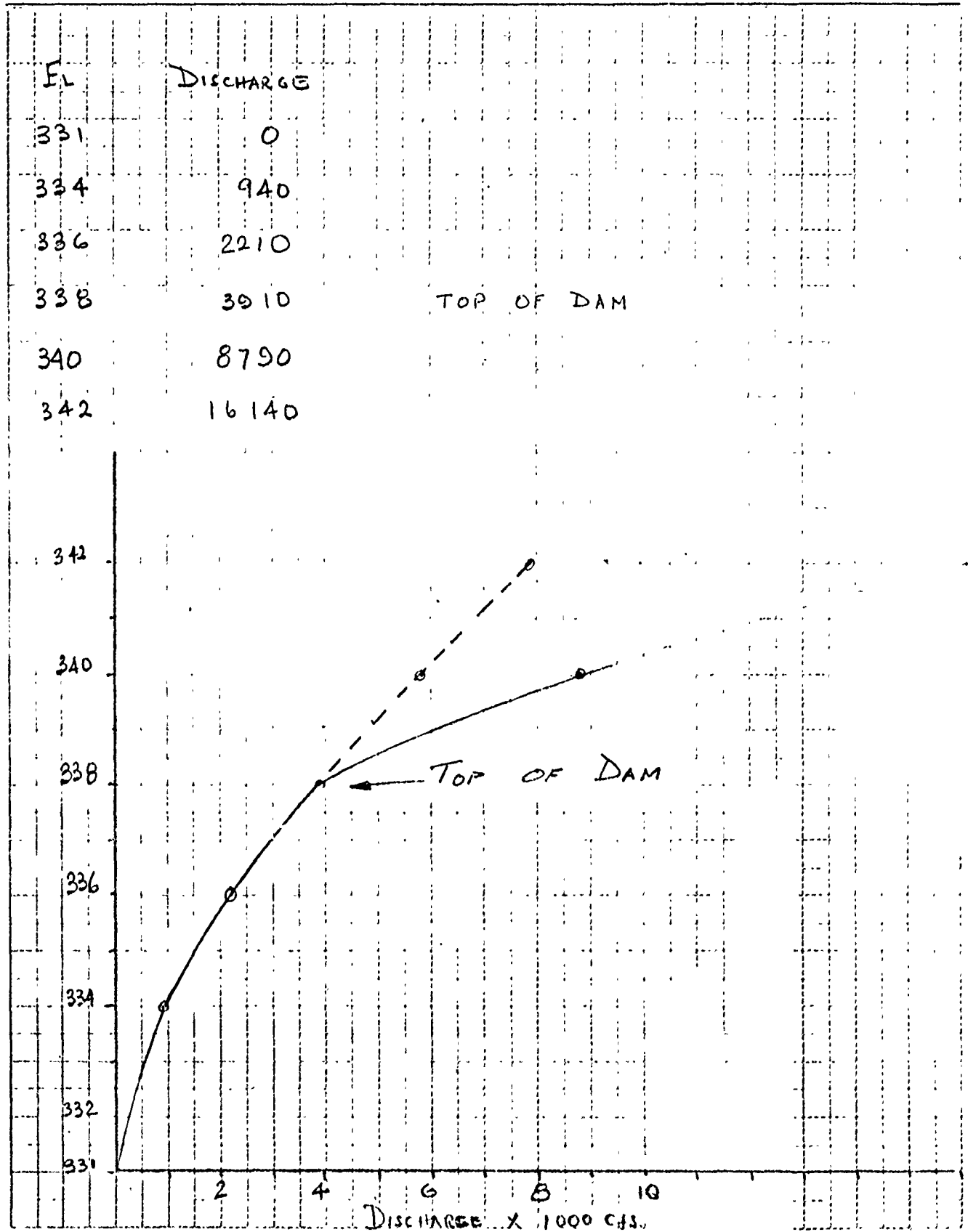
EL.	AREA	ΔH	MEAN AREA	$\Delta VOLUME$	SURCHARGE STORAGE
331	163.9				0
		3.0	166.6	499.8	
334	169.3				499.8
		2.0	172.6	345.2	
336	175.9				845
		2.0	179.6	359.2	
338	183.3				1204.2
		2.0	187.4	374.8	
340	191.5				1579



TAMS

Job No. 1551-07
 Project PHASE 1 DAM SAFETY INSPECTION.
 Subject BEAVERDAM LAKE.
OUTFLOW RATING CURVE & TABLE.

Sheet 3 of 5
 Date MAY 1 80
 By DLC.
 Ch'k. by _____



TAMS

Job No. 1551-07
 Project PHASE 1 INSPECTION BEAVER DAM LAKE
 Subject UNIT HYDROGRAPH COMPUTATION
SYNDER'S COEF. obtained from WRE Inc report.
- MOODNA CREEK NETWORK. (REF 2)

Sheet 4 of 5
 Date MAY 6 1980
 By DLC DLC
 Ch'k. by _____

$$L_{ca} = 3.83 \text{ miles}$$

$$L = 7.39 \text{ miles}$$

$$\text{DRAINAGE AREA} = 9.25 \text{ mi}^2$$

$$(LL_{ca})^{0.3} = 2.726$$

$$t_p = C_c (LL_{ca})^{0.3}$$

$$= (2.11)(2.726) = 5.75 \text{ hours}$$

$$t_n = \frac{5.75}{5.5} \sim 1 \text{ hour}$$

$$f_p = \frac{640 C_p}{t_p} = \frac{320}{5.75} = 55.65 \text{ cfs/sg mile}$$

$$Q_p = 515 \text{ cfs}$$

from Plot #7 EM 1110-2-1405

$$W75 = 5.9 \text{ hrs.}$$

$$W50 = 10 \text{ hrs}$$

TAMS

Job No. 1551-07

Project PHASE 1 INSPECTION BEAVER DAM LAKE

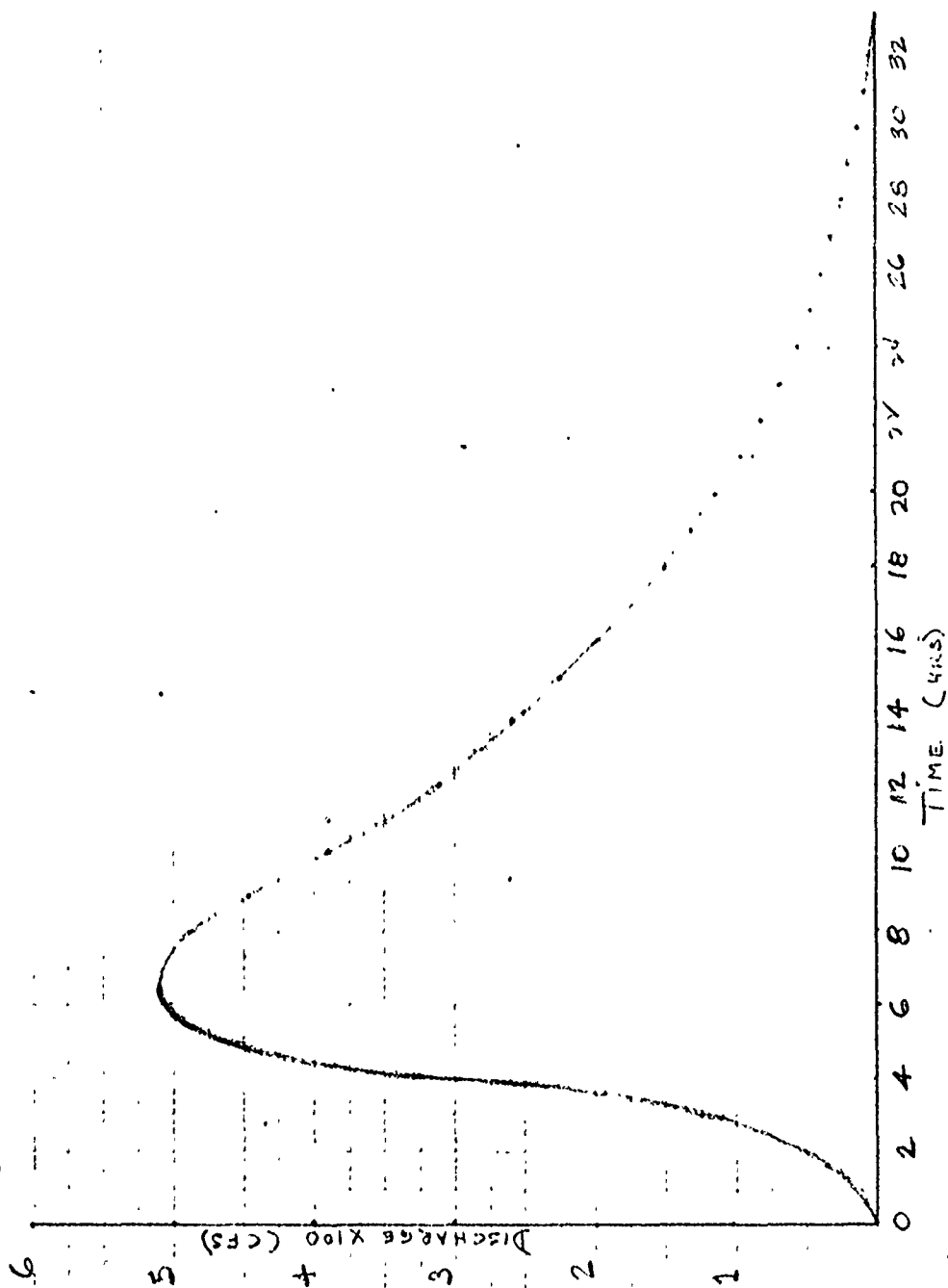
Subject UNIT HYDROGRAPH.

Sheet 5 of 5

Date MAY 6 1980

By DLC.

Ch'k. by _____



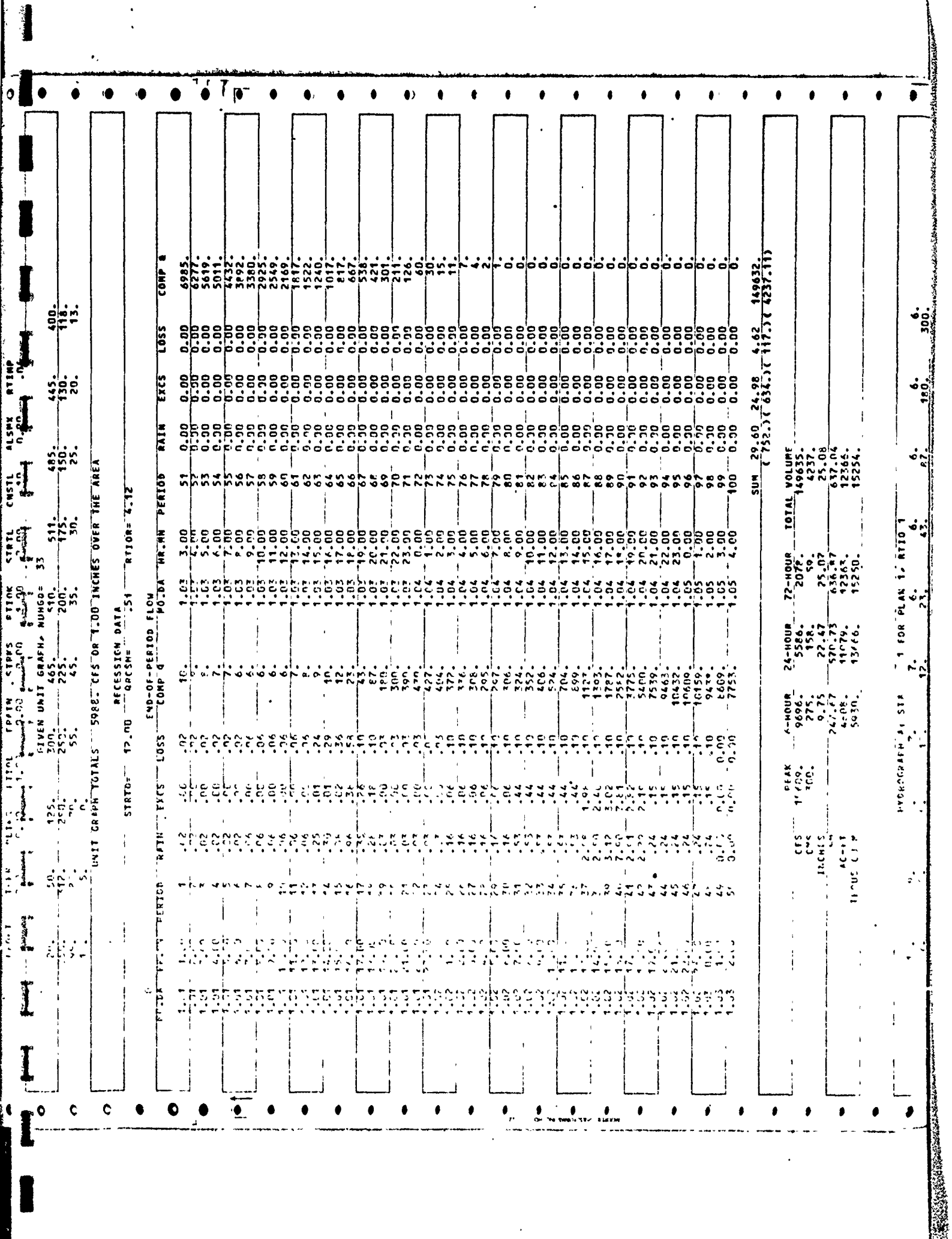
2. What is the purpose of the study?

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PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RIDGE HYDROGRAPH AT 1
ROUTE HYDROGRAPH TO 2
ROUTE HYDROGRAPH TO 3
ROUTE HYDROGRAPH TO 4
END OF NETWORK

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	52
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UNIT GRAPH TOTALS 5988. CFS OR 1.00 INCHES OVER THE AREA

RECESSION DATA
START= 12.00 QPCSN= .51 RTION= 4.12

PERIOD	RAIN	EXCS	LOSS	COMP 4	NO. DA	HR. MIN	PERIOD	RAIN	EXCS	LOSS	COMP 8
1	1.02	0.00	0.00	10.	1.03	3.00	51	0.00	0.00	0.00	6985.
2	1.02	0.00	0.00	10.	1.03	4.00	52	0.00	0.00	0.00	6277.
3	1.02	0.00	0.00	10.	1.03	5.00	53	0.00	0.00	0.00	5619.
4	1.02	0.00	0.00	10.	1.03	6.00	54	0.00	0.00	0.00	5011.
5	1.02	0.00	0.00	10.	1.03	7.00	55	0.00	0.00	0.00	4432.
6	1.02	0.00	0.00	10.	1.03	8.00	56	0.00	0.00	0.00	3892.
7	1.02	0.00	0.00	10.	1.03	9.00	57	0.00	0.00	0.00	3380.
8	1.02	0.00	0.00	10.	1.03	10.00	58	0.00	0.00	0.00	2925.
9	1.02	0.00	0.00	10.	1.03	11.00	59	0.00	0.00	0.00	2549.
10	1.02	0.00	0.00	10.	1.03	12.00	60	0.00	0.00	0.00	2169.
11	1.02	0.00	0.00	10.	1.03	13.00	61	0.00	0.00	0.00	1817.
12	1.02	0.00	0.00	10.	1.03	14.00	62	0.00	0.00	0.00	1522.
13	1.02	0.00	0.00	10.	1.03	15.00	63	0.00	0.00	0.00	1240.
14	1.02	0.00	0.00	10.	1.03	16.00	64	0.00	0.00	0.00	1011.
15	1.02	0.00	0.00	10.	1.03	17.00	65	0.00	0.00	0.00	817.
16	1.02	0.00	0.00	10.	1.03	18.00	66	0.00	0.00	0.00	667.
17	1.02	0.00	0.00	10.	1.03	19.00	67	0.00	0.00	0.00	538.
18	1.02	0.00	0.00	10.	1.03	20.00	68	0.00	0.00	0.00	421.
19	1.02	0.00	0.00	10.	1.03	21.00	69	0.00	0.00	0.00	301.
20	1.02	0.00	0.00	10.	1.03	22.00	70	0.00	0.00	0.00	211.
21	1.02	0.00	0.00	10.	1.03	23.00	71	0.00	0.00	0.00	126.
22	1.02	0.00	0.00	10.	1.04	0.00	72	0.00	0.00	0.00	60.
23	1.02	0.00	0.00	10.	1.04	1.00	73	0.00	0.00	0.00	30.
24	1.02	0.00	0.00	10.	1.04	2.00	74	0.00	0.00	0.00	15.
25	1.02	0.00	0.00	10.	1.04	3.00	75	0.00	0.00	0.00	7.
26	1.02	0.00	0.00	10.	1.04	4.00	76	0.00	0.00	0.00	4.
27	1.02	0.00	0.00	10.	1.04	5.00	77	0.00	0.00	0.00	2.
28	1.02	0.00	0.00	10.	1.04	6.00	78	0.00	0.00	0.00	1.
29	1.02	0.00	0.00	10.	1.04	7.00	79	0.00	0.00	0.00	0.
30	1.02	0.00	0.00	10.	1.04	8.00	80	0.00	0.00	0.00	0.
31	1.02	0.00	0.00	10.	1.04	9.00	81	0.00	0.00	0.00	0.
32	1.02	0.00	0.00	10.	1.04	10.00	82	0.00	0.00	0.00	0.
33	1.02	0.00	0.00	10.	1.04	11.00	83	0.00	0.00	0.00	0.
34	1.02	0.00	0.00	10.	1.04	12.00	84	0.00	0.00	0.00	0.
35	1.02	0.00	0.00	10.	1.04	13.00	85	0.00	0.00	0.00	0.
36	1.02	0.00	0.00	10.	1.04	14.00	86	0.00	0.00	0.00	0.
37	1.02	0.00	0.00	10.	1.04	15.00	87	0.00	0.00	0.00	0.
38	1.02	0.00	0.00	10.	1.04	16.00	88	0.00	0.00	0.00	0.
39	1.02	0.00	0.00	10.	1.04	17.00	89	0.00	0.00	0.00	0.
40	1.02	0.00	0.00	10.	1.04	18.00	90	0.00	0.00	0.00	0.
41	1.02	0.00	0.00	10.	1.04	19.00	91	0.00	0.00	0.00	0.
42	1.02	0.00	0.00	10.	1.04	20.00	92	0.00	0.00	0.00	0.
43	1.02	0.00	0.00	10.	1.04	21.00	93	0.00	0.00	0.00	0.
44	1.02	0.00	0.00	10.	1.04	22.00	94	0.00	0.00	0.00	0.
45	1.02	0.00	0.00	10.	1.04	23.00	95	0.00	0.00	0.00	0.
46	1.02	0.00	0.00	10.	1.05	0.00	96	0.00	0.00	0.00	0.
47	1.02	0.00	0.00	10.	1.05	1.00	97	0.00	0.00	0.00	0.
48	1.02	0.00	0.00	10.	1.05	2.00	98	0.00	0.00	0.00	0.
49	1.02	0.00	0.00	10.	1.05	3.00	99	0.00	0.00	0.00	0.
50	1.02	0.00	0.00	10.	1.05	4.00	100	0.00	0.00	0.00	0.

SUN 29.00 24.98 4.62 149632.
(752.3) (634.3) (117.3) (4237.11)

PEAK 1' 49. 9696. 5584. 2075. 149635.
CFS 1' 49. 9696. 5584. 2075. 149635.
INCHES 1' 49. 9696. 5584. 2075. 149635.
AC-FT 1' 49. 9696. 5584. 2075. 149635.
TOTAL VOLUME 149635.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTION 1
7. 6. 43. 6. 300.
12. 23. 43. 6. 300.

PEAK	1770.0	9696.0	5596.0	2078.0	149635.0
CFS	120.0	275.0	158.0	59.0	4237.0
INCHES		9.75	22.47	25.07	25.08
AC-FT	247.67	570.73	636.97	637.04	12365.0
THOUS CU Y	4095.0	11079.0	12363.0	12365.0	15254.0
	5030.0	13666.0	15250.0		

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 1									
1	2	3	4	5	6	7	8	9	10
1770.0	9696.0	5596.0	2078.0	149635.0					
120.0	275.0	158.0	59.0	4237.0					
9.75	22.47	25.07	25.08						
247.67	570.73	636.97	637.04						
4095.0	11079.0	12363.0	12365.0						
5030.0	13666.0	15250.0							

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 2									
1	2	3	4	5	6	7	8	9	10
1770.0	9696.0	5596.0	2078.0	149635.0					
120.0	275.0	158.0	59.0	4237.0					
9.75	22.47	25.07	25.08						
247.67	570.73	636.97	637.04						
4095.0	11079.0	12363.0	12365.0						
5030.0	13666.0	15250.0							

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 3									
1	2	3	4	5	6	7	8	9	10
1770.0	9696.0	5596.0	2078.0	149635.0					
120.0	275.0	158.0	59.0	4237.0					
9.75	22.47	25.07	25.08						
247.67	570.73	636.97	637.04						
4095.0	11079.0	12363.0	12365.0						
5030.0	13666.0	15250.0							

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 4									
1	2	3	4	5	6	7	8	9	10
1770.0	9696.0	5596.0	2078.0	149635.0					
120.0	275.0	158.0	59.0	4237.0					
9.75	22.47	25.07	25.08						
247.67	570.73	636.97	637.04						
4095.0	11079.0	12363.0	12365.0						
5030.0	13666.0	15250.0							

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 5									
1	2	3	4	5	6	7	8	9	10
1770.0	9696.0	5596.0	2078.0	149635.0					
120.0	275.0	158.0	59.0	4237.0					
9.75	22.47	25.07	25.08						
247.67	570.73	636.97	637.04						
4095.0	11079.0	12363.0	12365.0						
5030.0	13666.0	15250.0							

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 6									
1	2	3	4	5	6	7	8	9	10
1770.0	9696.0	5596.0	2078.0	149635.0					
120.0	275.0	158.0	59.0	4237.0					
9.75	22.47	25.07	25.08						
247.67	570.73	636.97	637.04						
4095.0	11079.0	12363.0	12365.0						
5030.0	13666.0	15250.0							

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 7									
1	2	3	4	5	6	7	8	9	10
1770.0	9696.0	5596.0	2078.0	149635.0					
120.0	275.0	158.0	59.0	4237.0					
9.75	22.47	25.07	25.08						
247.67	570.73	636.97	637.04						
4095.0	11079.0	12363.0	12365.0						
5030.0	13666.0	15250.0							

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 8									
1	2	3	4	5	6	7	8	9	10
1770.0	9696.0	5596.0	2078.0	149635.0					
120.0	275.0	158.0	59.0	4237.0					
9.75	22.47	25.07	25.08						
247.67	570.73	636.97	637.04						
4095.0	11079.0	12363.0	12365.0						
5030.0	13666.0	15250.0							

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 9									
1	2	3	4	5	6	7	8	9	10
1770.0	9696.0	5596.0	2078.0	149635.0					
120.0	275.0	158.0	59.0	4237.0					
9.75	22.47	25.07	25.08						
247.67	570.73	636.97	637.04						
4095.0	11079.0	12363.0	12365.0						
5030.0	13666.0	15250.0							

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 10									
1	2	3	4	5	6	7	8	9	10
1770.0	9696.0	5596.0	2078.0	149635.0					
120.0	275.0	158.0	59.0	4237.0					
9.75	22.47	25.07	25.08						
247.67	570.73	636.97	637.04						
4095.0	11079.0	12363.0	12365.0						
5030.0	13666.0	15250.0							

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 11									
1	2	3	4	5	6	7	8	9	10
1770.0	9696.0	5596.0	2078.0	149635.0					
120.0	275.0	158.0	59.0	4237.0					
9.75	22.47	25.07	25.08						
247.67	570.73	636.97	637.04						
4095.0	11079.0	12363.0	12365.0						
5030.0	13666.0	15250.0							

ISTG ICOP IFON IIDE JPLI JPRI INAME IJSTG IAUIG

CLASS CLASS AVG INES ISAME IOPT IPMP LSTR

MSIPS NSTOL LAG ARSKK X TSK STORA ISPRAT

STAGE 331.00 334.00 338.00 340.00 342.00

FLOW 940.00 940.00 940.00 940.00 940.00

CAPACITY 1640 1640 2290 2640

ELEVATION 331 334 338 338

CALL SPLIT COW EXPW TLEVEL CQGL CAREA EXPL

331.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

TOPEL COOD EXPD DAMWID

338.0 2.6 1.5 306

STATION 2, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

STORAGE

STAGE

STAGE

STAGE

STAGE

STAGE

STAGE

STAGE

STAGE

STAGE

STAGE

PEAK 14507

CFS 264

CFS 264

CFS 264

CFS 264

CFS 264

CFS 264

CFS 264

CFS 264

CFS 264

CFS 264

CFS 264

CFS 264

CFS 264

CFS 264

CFS 264

CFS 264

CFS 264

CFS 264

CFS 264

CFS 264

CFS 264

CFS 264

CFS 264

CFS 264

PEAK 6-HOUR 24-HOUR 72-HOUR TOTAL VOLUME
 107.7 154.3 207.1 72.0
 CFS 154.3 207.1 72.0
 1"CHES 26.0 35.0 12.5
 5.51 21.66 25.02
 241.68 555.37 635.61
 4692 10781 12339
 5797 13298 15220
 THOUS CU M

STATION 7+ PLAN 1, RATIO 2
 END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW				STORAGE			
1	2	3	4	1	2	3	4
1441	1441	1441	1441	1441	1441	1441	1441
1442	1442	1442	1442	1442	1442	1442	1442
1443	1443	1443	1443	1443	1443	1443	1443
1444	1444	1444	1444	1444	1444	1444	1444
1445	1445	1445	1445	1445	1445	1445	1445
1446	1446	1446	1446	1446	1446	1446	1446
1447	1447	1447	1447	1447	1447	1447	1447
1448	1448	1448	1448	1448	1448	1448	1448
1449	1449	1449	1449	1449	1449	1449	1449
1450	1450	1450	1450	1450	1450	1450	1450
1451	1451	1451	1451	1451	1451	1451	1451
1452	1452	1452	1452	1452	1452	1452	1452
1453	1453	1453	1453	1453	1453	1453	1453
1454	1454	1454	1454	1454	1454	1454	1454
1455	1455	1455	1455	1455	1455	1455	1455
1456	1456	1456	1456	1456	1456	1456	1456
1457	1457	1457	1457	1457	1457	1457	1457
1458	1458	1458	1458	1458	1458	1458	1458
1459	1459	1459	1459	1459	1459	1459	1459
1460	1460	1460	1460	1460	1460	1460	1460
1461	1461	1461	1461	1461	1461	1461	1461
1462	1462	1462	1462	1462	1462	1462	1462
1463	1463	1463	1463	1463	1463	1463	1463
1464	1464	1464	1464	1464	1464	1464	1464
1465	1465	1465	1465	1465	1465	1465	1465
1466	1466	1466	1466	1466	1466	1466	1466
1467	1467	1467	1467	1467	1467	1467	1467
1468	1468	1468	1468	1468	1468	1468	1468
1469	1469	1469	1469	1469	1469	1469	1469
1470	1470	1470	1470	1470	1470	1470	1470
1471	1471	1471	1471	1471	1471	1471	1471
1472	1472	1472	1472	1472	1472	1472	1472
1473	1473	1473	1473	1473	1473	1473	1473
1474	1474	1474	1474	1474	1474	1474	1474
1475	1475	1475	1475	1475	1475	1475	1475
1476	1476	1476	1476	1476	1476	1476	1476
1477	1477	1477	1477	1477	1477	1477	1477
1478	1478	1478	1478	1478	1478	1478	1478
1479	1479	1479	1479	1479	1479	1479	1479
1480	1480	1480	1480	1480	1480	1480	1480
1481	1481	1481	1481	1481	1481	1481	1481
1482	1482	1482	1482	1482	1482	1482	1482
1483	1483	1483	1483	1483	1483	1483	1483
1484	1484	1484	1484	1484	1484	1484	1484
1485	1485	1485	1485	1485	1485	1485	1485
1486	1486	1486	1486	1486	1486	1486	1486
1487	1487	1487	1487	1487	1487	1487	1487
1488	1488	1488	1488	1488	1488	1488	1488
1489	1489	1489	1489	1489	1489	1489	1489
1490	1490	1490	1490	1490	1490	1490	1490
1491	1491	1491	1491	1491	1491	1491	1491
1492	1492	1492	1492	1492	1492	1492	1492
1493	1493	1493	1493	1493	1493	1493	1493
1494	1494	1494	1494	1494	1494	1494	1494
1495	1495	1495	1495	1495	1495	1495	1495
1496	1496	1496	1496	1496	1496	1496	1496
1497	1497	1497	1497	1497	1497	1497	1497
1498	1498	1498	1498	1498	1498	1498	1498
1499	1499	1499	1499	1499	1499	1499	1499
1500	1500	1500	1500	1500	1500	1500	1500

PEAK OUTFLOW IS 470 CFS AT TIME 45.00 HOURS

PEAK 6-HOUR 24-HOUR 72-HOUR TOTAL VOLUME
 470 2654 1076 74787
 CFS 470 2654 1076 74787
 1"CHES 4.24 10.68 12.51
 110.35 271.15 317.65
 2162 5264 6166
 THOUS CU M 2642 6493 7606

HYDROGRAPH ROUTING
 CHANNEL ROUTING REACH#1 0+00 TO 2+00

ISTAG	ICOMP	IECON	ITYPE	JPLT	JPRP	INAME	ISTAGE	IAUTO
1	1	0	0	0	0	0	0	0
ROUTING DATA								
QLOSS	CLASS	AVG	IRIS	ISAME	ISPT	IPMP	LSTR	
0.0	0.00	0.00	1	1	0	0	0	
NTS	NTSL	LAG	APSKK	X	TSK	STORA	ISPRAT	
1	0	0.000	0.000	0.000	0.000	0	0	

CHANNEL ROUTING REACHMT 0+00 TO 2+00

ISTAG ICOMP IECON ITAPE JPLT JPRT INAME ISTAGE IAUO

ROUTING DATA
OLOSS CROSS AVG IRES TSAME IOPT IPMP LSTR

NSIPS NSTBL LAG APSKK X TSK STORA ISPRAT

CHANNEL ROUTING

GN(1) GN(2) GN(3) ELNVT ELMAX RLNTH SEL

CROSS SECTION COORDINATES--STA=ELNVT STA=FLEV--ETC

STORAGE 0+00 19.66 27.51 31.69 33.32 36.00 40.44 5.11 7.28 9.81 12.71 15.98

OUTFLOW 210.55 210.55 210.55 210.55 210.55 210.55 210.55 210.55 210.55 210.55 210.55 210.55

STAGE 291.00 291.00 291.00 291.00 291.00 291.00 291.00 291.00 291.00 291.00 291.00 291.00

FLOW 210.55 210.55 210.55 210.55 210.55 210.55 210.55 210.55 210.55 210.55 210.55 210.55

STATION 3. PLAN 1. RTIO 1

OUTFLOW

3. 7. 107. 167. 207. 247. 287. 327. 367. 407. 447. 487. 527. 567. 607. 647. 687. 727. 767. 807. 847. 887. 927. 967. 1007. 1047. 1087. 1127. 1167. 1207. 1247. 1287. 1327. 1367. 1407. 1447. 1487. 1527. 1567. 1607. 1647. 1687. 1727. 1767. 1807. 1847. 1887. 1927. 1967. 2007. 2047. 2087. 2127. 2167. 2207. 2247. 2287. 2327. 2367. 2407. 2447. 2487. 2527. 2567. 2607. 2647. 2687. 2727. 2767. 2807. 2847. 2887. 2927. 2967. 3007. 3047. 3087. 3127. 3167. 3207. 3247. 3287. 3327. 3367. 3407. 3447. 3487. 3527. 3567. 3607. 3647. 3687. 3727. 3767. 3807. 3847. 3887. 3927. 3967. 4007. 4047. 4087. 4127. 4167. 4207. 4247. 4287. 4327. 4367. 4407. 4447. 4487. 4527. 4567. 4607. 4647. 4687. 4727. 4767. 4807. 4847. 4887. 4927. 4967. 5007. 5047. 5087. 5127. 5167. 5207. 5247. 5287. 5327. 5367. 5407. 5447. 5487. 5527. 5567. 5607. 5647. 5687. 5727. 5767. 5807. 5847. 5887. 5927. 5967. 6007. 6047. 6087. 6127. 6167. 6207. 6247. 6287. 6327. 6367. 6407. 6447. 6487. 6527. 6567. 6607. 6647. 6687. 6727. 6767. 6807. 6847. 6887. 6927. 6967. 7007. 7047. 7087. 7127. 7167. 7207. 7247. 7287. 7327. 7367. 7407. 7447. 7487. 7527. 7567. 7607. 7647. 7687. 7727. 7767. 7807. 7847. 7887. 7927. 7967. 8007. 8047. 8087. 8127. 8167. 8207. 8247. 8287. 8327. 8367. 8407. 8447. 8487. 8527. 8567. 8607. 8647. 8687. 8727. 8767. 8807. 8847. 8887. 8927. 8967. 9007. 9047. 9087. 9127. 9167. 9207. 9247. 9287. 9327. 9367. 9407. 9447. 9487. 9527. 9567. 9607. 9647. 9687. 9727. 9767. 9807. 9847. 9887. 9927. 9967. 10007. 10047. 10087. 10127. 10167. 10207. 10247. 10287. 10327. 10367. 10407. 10447. 10487. 10527. 10567. 10607. 10647. 10687. 10727. 10767. 10807. 10847. 10887. 10927. 10967. 11007. 11047. 11087. 11127. 11167. 11207. 11247. 11287. 11327. 11367. 11407. 11447. 11487. 11527. 11567. 11607. 11647. 11687. 11727. 11767. 11807. 11847. 11887. 11927. 11967. 12007. 12047. 12087. 12127. 12167. 12207. 12247. 12287. 12327. 12367. 12407. 12447. 12487. 12527. 12567. 12607. 12647. 12687. 12727. 12767. 12807. 12847. 12887. 12927. 12967. 13007. 13047. 13087. 13127. 13167. 13207. 13247. 13287. 13327. 13367. 13407. 13447. 13487. 13527. 13567. 13607. 13647. 13687. 13727. 13767. 13807. 13847. 13887. 13927. 13967. 14007. 14047. 14087. 14127. 14167. 14207. 14247. 14287. 14327. 14367. 14407. 14447. 14487. 14527. 14567. 14607. 14647. 14687. 14727. 14767. 14807. 14847. 14887. 14927. 14967. 15007. 15047. 15087. 15127. 15167. 15207. 15247. 15287. 15327. 15367. 15407. 15447. 15487. 15527. 15567. 15607. 15647. 15687. 15727. 15767. 15807. 15847. 15887. 15927. 15967. 16007. 16047. 16087. 16127. 16167. 16207. 16247. 16287. 16327. 16367. 16407. 16447. 16487. 16527. 16567. 16607. 16647. 16687. 16727. 16767. 16807. 16847. 16887. 16927. 16967. 17007. 17047. 17087. 17127. 17167. 17207. 17247. 17287. 17327. 17367. 17407. 17447. 17487. 17527. 17567. 17607. 17647. 17687. 17727. 17767. 17807. 17847. 17887. 17927. 17967. 18007. 18047. 18087. 18127. 18167. 18207. 18247. 18287. 18327. 18367. 18407. 18447. 18487. 18527. 18567. 18607. 18647. 18687. 18727. 18767. 18807. 18847. 18887. 18927. 18967. 19007. 19047. 19087. 19127. 19167. 19207. 19247. 19287. 19327. 19367. 19407. 19447. 19487. 19527. 19567. 19607. 19647. 19687. 19727. 19767. 19807. 19847. 19887. 19927. 19967. 20007. 20047. 20087. 20127. 20167. 20207. 20247. 20287. 20327. 20367. 20407. 20447. 20487. 20527. 20567. 20607. 20647. 20687. 20727. 20767. 20807. 20847. 20887. 20927. 20967. 21007. 21047. 21087. 21127. 21167. 21207. 21247. 21287. 21327. 21367. 21407. 21447. 21487. 21527. 21567. 21607. 21647. 21687. 21727. 21767. 21807. 21847. 21887. 21927. 21967. 22007. 22047. 22087. 22127. 22167. 22207. 22247. 22287. 22327. 22367. 22407. 22447. 22487. 22527. 22567. 22607. 22647. 22687. 22727. 22767. 22807. 22847. 22887. 22927. 22967. 23007. 23047. 23087. 23127. 23167. 23207. 23247. 23287. 23327. 23367. 23407. 23447. 23487. 23527. 23567. 23607. 23647. 23687. 23727. 23767. 23807. 23847. 23887. 23927. 23967. 24007. 24047. 24087. 24127. 24167. 24207. 24247. 24287. 24327. 24367. 24407. 24447. 24487. 24527. 24567. 24607. 24647. 24687. 24727. 24767. 24807. 24847. 24887. 24927. 24967. 25007. 25047. 25087. 25127. 25167. 25207. 25247. 25287. 25327. 25367. 25407. 25447. 25487. 25527. 25567. 25607. 25647. 25687. 25727. 25767. 25807. 25847. 25887. 25927. 25967. 26007. 26047. 26087. 26127. 26167. 26207. 26247. 26287. 26327. 26367. 26407. 26447. 26487. 26527. 26567. 26607. 26647. 26687. 26727. 26767. 26807. 26847. 26887. 26927. 26967. 27007. 27047. 27087. 27127. 27167. 27207. 27247. 27287. 27327. 27367. 27407. 27447. 27487. 27527. 27567. 27607. 27647. 27687. 27727. 27767. 27807. 27847. 27887. 27927. 27967. 28007. 28047. 28087. 28127. 28167. 28207. 28247. 28287. 28327. 28367. 28407. 28447. 28487. 28527. 28567. 28607. 28647. 28687. 28727. 28767. 28807. 28847. 28887. 28927. 28967. 29007. 29047. 29087. 29127. 29167. 29207. 29247. 29287. 29327. 29367. 29407. 29447. 29487. 29527. 29567. 29607. 29647. 29687. 29727. 29767. 29807. 29847. 29887. 29927. 29967. 30007. 30047. 30087. 30127. 30167. 30207. 30247. 30287. 30327. 30367. 30407. 30447. 30487. 30527. 30567. 30607. 30647. 30687. 30727. 30767. 30807. 30847. 30887. 30927. 30967. 31007. 31047. 31087. 31127. 31167. 31207. 31247. 31287. 31327. 31367. 31407. 31447. 31487. 31527. 31567. 31607. 31647. 31687. 31727. 31767. 31807. 31847. 31887. 31927. 31967. 32007. 32047. 32087. 32127. 32167. 32207. 32247. 32287. 32327. 32367. 32407. 32447. 32487. 32527. 32567. 32607. 32647. 32687. 32727. 32767. 32807. 32847. 32887. 32927. 32967. 33007. 33047. 33087. 33127. 33167. 33207. 33247. 33287. 33327. 33367. 33407. 33447. 33487. 33527. 33567. 33607. 33647. 33687. 33727. 33767. 33807. 33847. 33887. 33927. 33967. 34007. 34047. 34087. 34127. 34167. 34207. 34247. 34287. 34327. 34367. 34407. 34447. 34487. 34527. 34567. 34607. 34647. 34687. 34727. 34767. 34807. 34847. 34887. 34927. 34967. 35007. 35047. 35087. 35127. 35167. 35207. 35247. 35287. 35327. 35367. 35407. 35447. 35487. 35527. 35567. 35607. 35647. 35687. 35727. 35767. 35807. 35847. 35887. 35927. 35967. 36007. 36047. 36087. 36127. 36167. 36207. 36247. 36287. 36327. 36367. 36407. 36447. 36487. 36527. 36567. 36607. 36647. 36687. 36727. 36767. 36807. 36847. 36887. 36927. 36967. 37007. 37047. 37087. 37127. 37167. 37207. 37247. 37287. 37327. 37367. 37407. 37447. 37487. 37527. 37567. 37607. 37647. 37687. 37727. 37767. 37807. 37847. 37887. 37927. 37967. 38007. 38047. 38087. 38127. 38167. 38207. 38247. 38287. 38327. 38367. 38407. 38447. 38487. 38527. 38567. 38607. 38647. 38687. 38727. 38767. 38807. 38847. 38887. 38927. 38967. 39007. 39047. 39087. 39127. 39167. 39207. 39247. 39287. 39327. 39367. 39407. 39447. 39487. 39527. 39567. 39607. 39647. 39687. 39727. 39767. 39807. 39847. 39887. 39927. 39967. 40007. 40047. 40087. 40127. 40167. 40207. 40247. 40287. 40327. 40367. 40407. 40447. 40487. 40527. 40567. 40607. 40647. 40687. 40727. 40767. 40807. 40847. 40887. 40927. 40967. 41007. 41047. 41087. 41127. 41167. 41207. 41247. 41287. 41327. 41367. 41407. 41447. 41487. 41527. 41567. 41607. 41647. 41687. 41727. 41767. 41807. 41847. 41887. 41927. 41967. 42007. 42047. 42087. 42127. 42167. 42207. 42247. 42287. 42327. 42367. 42407. 42447. 42487. 42527. 42567. 42607. 42647. 42687. 42727. 42767. 42807. 42847. 42887. 42927. 42967. 43007. 43047. 43087. 43127. 43167. 43207. 43247. 43287. 43327. 43367. 43407. 43447. 43487. 43527. 43567. 43607. 43647. 43687. 43727. 43767. 43807. 43847. 43887. 43927. 43967. 44007. 44047. 44087. 44127. 44167. 44207. 44247. 44287. 44327. 44367. 44407. 44447. 44487. 44527. 44567. 44607. 44647. 44687. 44727. 44767. 44807. 44847. 44887. 44927. 44967. 45007. 45047. 45087. 45127. 45167. 45207. 45247. 45287. 45327. 45367. 45407. 45447. 45487. 45527. 45567. 45607. 45647. 45687. 45727. 45767. 45807. 45847. 45887. 45927. 45967. 46007. 46047. 46087. 46127. 46167. 46207. 46247. 46287. 46327. 46367. 46407. 46447. 46487. 46527. 46567. 46607. 46647. 46687. 46727. 46767. 46807. 46847. 46887. 46927. 46967. 47007. 47047. 47087. 47127. 47167. 47207. 47247. 47287. 47327. 47367. 47407. 47447. 47487. 47527. 47567. 47607. 47647. 47687. 47727. 47767. 47807. 47847. 47887. 47927. 47967. 48007. 48047. 48087. 48127. 48167. 48207. 48247. 48287. 48327. 48367. 48407. 48447. 48487. 48527. 48567. 48607. 48647. 48687. 48727. 48767. 48807. 48847. 48887. 48927. 48967. 49007. 49047. 49087. 49127. 49167. 49207. 49247. 49287. 49327. 49367. 49407. 49447. 49487. 49527. 49567. 49607. 49647. 49687. 49727. 49767. 49807. 49847. 49887. 49927. 49967. 50007. 50047. 50087. 50127. 50167. 50207. 50247. 50287. 50327. 50367. 50407. 50447. 50487. 50527. 50567. 50607. 50647. 50687. 50727. 50767. 50807. 50847. 50887. 50927. 50967. 51007. 51047. 51087. 51127. 51167. 51207. 51247. 51287. 51327. 51367. 51407. 51447. 51487. 51527. 51567. 51607. 51647. 51687. 51727. 51767. 51807. 51847. 51887. 51927. 51967. 52007. 52047. 52087. 52127. 52167. 52207. 52247. 52287. 52327. 52367. 52407. 52447. 52487. 52527. 52567. 52607. 52647. 52687. 52727. 52767. 52807. 52847. 52887. 52927. 52967. 53007. 53047. 53087. 53127. 53167. 53207. 53247. 53287. 53327. 53367. 53407. 53447. 53487. 53527. 53567. 53607. 53647. 53687. 53727. 53767. 53807. 53847. 53887. 53927. 53967. 54007. 54047. 54087. 54127. 54167. 54207. 54247. 54287. 54327. 54367. 54407. 54447. 54487. 54527. 54567. 54607. 54647. 54687. 54727. 54767. 54807. 54847. 54887. 54927. 54967. 55007. 55047. 55087. 55127. 55167. 55207. 55247. 55287. 55327. 55367. 55407. 55447. 55487. 55527. 55567. 55607. 55647. 55687. 55727. 55767. 55807. 55847. 55887. 55927. 55967. 56007. 56047. 56087. 56127. 56167. 56207. 56247. 56287. 56327. 56367. 56407. 56447. 56487. 56527. 56567. 56607. 56647. 56687. 56727. 56767. 56807. 56847. 56887. 56927. 56967. 57007. 57047. 57087. 57127. 57167. 57207. 57247. 57287. 57327. 57367. 57407. 57447. 57487. 57527. 57567. 57607. 57647. 57687. 57727. 57767. 57807. 57847. 57887. 57927. 57967. 58007. 58047. 58087. 58127. 58167. 58207. 58247. 58287. 58327. 58367. 58407. 58447. 58487. 58527. 58567. 58607. 58647. 58687. 58727. 58767. 58807. 58847. 58887. 58927. 58967. 59007. 59047. 59087. 59127. 59167. 59207. 59247. 59287. 59327. 59367. 59407. 59447. 59487. 59527. 59567. 59607. 59647. 59687. 59727. 59767. 59807. 59847. 59887. 59927. 59967. 60007. 60047. 60087. 60127. 60167. 60207. 60247. 60287. 60327. 60367. 60407. 60447. 60487. 60527. 60567. 60607. 60647. 60687. 60727. 60767. 60807. 60847. 60887. 60927. 60967. 61007. 61047. 61087. 61127. 61167. 61207. 61247. 61287. 61327. 61367. 61407. 61447. 61487. 61527. 61567. 61607. 61647. 61687. 61727. 61767. 61807. 61847. 61887. 61927. 61967. 62007. 62047. 62087. 62127. 62167. 62207. 62247. 62287. 62327. 62367. 62407. 62447. 62487. 62527. 62567. 62607. 62647. 62687. 62727. 62767. 62807. 62847. 62887. 62927. 62967. 63007. 63047. 63087. 63127. 63167. 63207. 63247. 63287. 63327. 63367. 63407. 63447. 63487. 63527. 63567. 63607. 63647. 63687. 63727. 63767. 63807. 63847. 63887. 63927. 63967. 64007. 64047. 64087. 64127. 64167. 64207. 64247. 64287. 64327. 64367. 64407. 64447. 64487. 64527. 64567. 64607. 64647. 64687. 64727. 64767. 64807. 64847. 64887. 64927. 64967. 65007. 65047. 65087. 65127. 65167. 65207. 65247. 65287. 65327. 65367. 65407. 65447. 65487. 65527. 65567. 65607. 65647. 65687. 65727. 65767. 65807. 65847. 65887. 65927. 65967. 66007. 66047. 66087. 66127. 66167. 66207. 66247. 66287. 66327. 66367. 66407. 66447. 66487. 66527. 66567. 66607. 66647. 66687. 66727. 66767. 66807.

[illegible]

MAXIMUM STORAGE = 1

2:51a SI 49Y15 00.18Y16

HYDROGRAPH ROUTING

CHANNEL ROUTING REACH 2 200 TO 900

| ISIA2 | ICOMP | IECON | ITAPE | JPLT | JPRY | INAME | ISTAGE | IAUTO |
|-------|-------|-------|-------|------|------|-------|--------|-------|
| 1 | 1 | 0 | 0 | 0 | 0 | | 0 | 0 |

| ROUTINE DATA | | | | | | | | | |
|--------------|-------|------|------|-------|------|------|------|---|---|
| QLOSS | FLOSS | 2VG | IRFS | ISAMF | IOPT | IPMP | LSTR | Q | U |
| 0.0 | 0.000 | 0.00 | 4 | 4 | 0 | 0 | 0 | 0 | 0 |

| INSTPS | NSTDL | LAG | APSKK | X | YSK | STORA | ISPRAT |
|--------|-------|-----|-------|-------|-------|-------|--------|
| 1 | 0 | 0 | 0.000 | 0.000 | 0.000 | 0 | 0 |

6WIT000 730.000 413.00 77000000

| | CY(1) | CY(2) | FLGVT | ELMAX | RLNTH | SER |
|--|-------|-------|-------|-------|-------|--------|
| | .0220 | .9360 | 295.0 | 710.0 | 700. | .00430 |

| CROSS SECTION COORDINATES--STA,FLW,STA,ELEV--ETC | | | |
|--|--------|--------|--------|
| 100.00 | 310.10 | 200.00 | 299.00 |
| 120.00 | 310.00 | 300.00 | 310.00 |
| 140.00 | 310.00 | 150.00 | 310.00 |
| 160.00 | 310.00 | 310.00 | 310.00 |
| 180.00 | 310.00 | 310.00 | 310.00 |
| 200.00 | 310.00 | 310.00 | 310.00 |
| 220.00 | 310.00 | 310.00 | 310.00 |
| 240.00 | 310.00 | 310.00 | 310.00 |
| 260.00 | 310.00 | 310.00 | 310.00 |
| 280.00 | 310.00 | 310.00 | 310.00 |
| 300.00 | 310.00 | 310.00 | 310.00 |
| 320.00 | 310.00 | 310.00 | 310.00 |
| 340.00 | 310.00 | 310.00 | 310.00 |
| 360.00 | 310.00 | 310.00 | 310.00 |
| 380.00 | 310.00 | 310.00 | 310.00 |
| 400.00 | 310.00 | 310.00 | 310.00 |
| 420.00 | 310.00 | 310.00 | 310.00 |
| 440.00 | 310.00 | 310.00 | 310.00 |
| 460.00 | 310.00 | 310.00 | 310.00 |
| 480.00 | 310.00 | 310.00 | 310.00 |
| 500.00 | 310.00 | 310.00 | 310.00 |
| 520.00 | 310.00 | 310.00 | 310.00 |
| 540.00 | 310.00 | 310.00 | 310.00 |
| 560.00 | 310.00 | 310.00 | 310.00 |
| 580.00 | 310.00 | 310.00 | 310.00 |
| 600.00 | 310.00 | 310.00 | 310.00 |
| 620.00 | 310.00 | 310.00 | 310.00 |
| 640.00 | 310.00 | 310.00 | 310.00 |
| 660.00 | 310.00 | 310.00 | 310.00 |
| 680.00 | 310.00 | 310.00 | 310.00 |
| 700.00 | 310.00 | 310.00 | 310.00 |
| 720.00 | 310.00 | 310.00 | 310.00 |
| 740.00 | 310.00 | 310.00 | 310.00 |
| 760.00 | 310.00 | 310.00 | 310.00 |
| 780.00 | 310.00 | 310.00 | 310.00 |
| 800.00 | 310.00 | 310.00 | 310.00 |
| 820.00 | 310.00 | 310.00 | 310.00 |
| 840.00 | 310.00 | 310.00 | 310.00 |
| 860.00 | 310.00 | 310.00 | 310.00 |
| 880.00 | 310.00 | 310.00 | 310.00 |
| 900.00 | 310.00 | 310.00 | 310.00 |
| 920.00 | 310.00 | 310.00 | 310.00 |
| 940.00 | 310.00 | 310.00 | 310.00 |
| 960.00 | 310.00 | 310.00 | 310.00 |
| 980.00 | 310.00 | 310.00 | 310.00 |
| 1000.00 | 310.00 | 310.00 | 310.00 |

[illegible]

| CUTFLD | 11-60 | 2-1 | 48-65 | 104-78 | 189-99 | 427-40 | 2281-55 | 5716-51 | 10591-57 |
|-----------|----------|----------|----------|----------|-----------|----------|-----------|-----------|-----------|
| 169001-52 | 24850-92 | 34300-35 | 45622-69 | 58633-89 | 173503-41 | 90300-52 | 109130-03 | 130041-91 | 153121-22 |

| | | | | | | | | | | |
|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| STAGE | 295.06 | 295.79 | 296.28 | 297.37 | 298.16 | 298.95 | 299.74 | 300.53 | 301.32 | 302.11 |
| | 302.64 | 304.47 | 305.26 | 306.05 | 306.84 | 307.63 | 308.42 | 309.21 | 310.00 | |

| FLOR | '06 | '07 | '08 | '09 | '10 | '11 |
|------|---------|---------|----------|----------|----------|-----------|
| FLOR | 2.6 | 16.50 | 48.65 | 104.78 | 100.99 | 2281.55 |
| | 2455.62 | 3430.35 | 45622.40 | 58633.89 | 73503.41 | 90309.52 |
| | | | | | | 109130.03 |
| | | | | | | 130041.91 |
| | | | | | | 133121.22 |
| | | | | | | 10591.57 |
| | | | | | | 5716.51 |

STATION 4, PLAN 1, P110 1

OUTFLOW

[illegible]

| | | | | | | | | |
|------|------|------|-------|-------|--------|-------|-------|-------|
| 324. | 293. | 304. | 326. | 364. | 516. | 614. | 758. | 974. |
| 327. | 252. | 317. | 6604. | 9477. | 10361. | 9854. | 9166. | 8316. |

| | | | | | | | | |
|------|------|-------|-------|-------|-------|------|------|------|
| 705. | 747. | 1873. | 1601. | 1368. | 1179. | 991. | 802. | 788. |
| 703. | 413. | 573. | 399. | 347. | 295. | 253. | 216. | 185. |
| 701. | 413. | 547. | 399. | 347. | 295. | 253. | 216. | 185. |

| | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|----|
| 77. | 70. | 74. | 21. | 18. | 16. | 13. | 11. | 10. | 8. |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|----|

4

[illegible]

| | | | | | | |
|----|-----|-----|-----|-----|-----|-----|
| 7. | 12. | 23. | 26. | 27. | 22. | 21. |
| 1. | 17. | 16. | 14. | 13. | 12. | 11. |

1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59. 60. 61. 62. 63. 64. 65. 66. 67. 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80. 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92. 93. 94. 95. 96. 97. 98. 99. 100. 101. 102. 103. 104. 105. 106. 107. 108. 109. 110. 111. 112. 113. 114. 115. 116. 117. 118. 119. 120. 121. 122. 123. 124. 125. 126. 127. 128. 129. 130. 131. 132. 133. 134. 135. 136. 137. 138. 139. 140. 141. 142. 143. 144. 145. 146. 147. 148. 149. 150. 151. 152. 153. 154. 155. 156. 157. 158. 159. 160. 161. 162. 163. 164. 165. 166. 167. 168. 169. 170. 171. 172. 173. 174. 175. 176. 177. 178. 179. 180. 181. 182. 183. 184. 185. 186. 187. 188. 189. 190. 191. 192. 193. 194. 195. 196. 197. 198. 199. 200. 201. 202. 203. 204. 205. 206. 207. 208. 209. 210. 211. 212. 213. 214. 215. 216. 217. 218. 219. 220. 221. 222. 223. 224. 225. 226. 227. 228. 229. 230. 231. 232. 233. 234. 235. 236. 237. 238. 239. 240. 241. 242. 243. 244. 245. 246. 247. 248. 249. 250. 251. 252. 253. 254. 255. 256. 257. 258. 259. 260. 261. 262. 263. 264. 265. 266. 267. 268. 269. 270. 271. 272. 273. 274. 275. 276. 277. 278. 279. 280. 281. 282. 283. 284. 285. 286. 287. 288. 289. 290. 291. 292. 293. 294. 295. 296. 297. 298. 299. 300. 301. 302. 303. 304. 305. 306. 307. 308. 309. 310. 311. 312. 313. 314. 315. 316. 317. 318. 319. 320. 321. 322. 323. 324. 325. 326. 327. 328. 329. 330. 331. 332. 333. 334. 335. 336. 337. 338. 339. 340. 341. 342. 343. 344. 345. 346. 347. 348. 349. 350. 351. 352. 353. 354. 355. 356. 357. 358. 359. 360. 361. 362. 363. 364. 365. 366. 367. 368. 369. 370. 371. 372. 373. 374. 375. 376. 377. 378. 379. 380. 381. 382. 383. 384. 385. 386. 387. 388. 389. 390. 391. 392. 393. 394. 395. 396. 397. 398. 399. 400. 401. 402. 403. 404. 405. 406. 407. 408. 409. 410. 411. 412. 413. 414. 415. 416. 417. 418. 419. 420. 421. 422. 423. 424. 425. 426. 427. 428. 429. 430. 431. 432. 433. 434. 435. 436. 437. 438. 439. 440. 441. 442. 443. 444. 445. 446. 447. 448. 449. 450. 451. 452. 453. 454. 455. 456. 457. 458. 459. 460. 461. 462. 463. 464. 465. 466. 467. 468. 469. 470. 471. 472. 473. 474. 475. 476. 477. 478. 479. 480. 481. 482. 483. 484. 485. 486. 487. 488. 489. 490. 491. 492. 493. 494. 495. 496. 497. 498. 499. 500. 501. 502. 503. 504. 505. 506. 507. 508. 509. 510. 511. 512. 513. 514. 515. 516. 517. 518. 519. 520. 521. 522. 523. 524. 525. 526. 527. 528. 529. 530. 531. 532. 533. 534. 535. 536. 537. 538. 539. 540. 541. 542. 543. 544. 545. 546. 547. 548. 549. 550. 551. 552. 553. 554. 555. 556. 557. 558. 559. 560. 561. 562. 563. 564. 565. 566. 567. 568. 569. 570. 571. 572. 573. 574. 575. 576. 577. 578. 579. 580. 581. 582. 583. 584. 585. 586. 587. 588. 589. 590. 591. 592. 593. 594. 595. 596. 597. 598. 599. 600. 601. 602. 603. 604. 605. 606. 607. 608. 609. 610. 611. 612. 613. 614. 615. 616. 617. 618. 619. 620. 621. 622. 623. 624. 625. 626. 627. 628. 629. 630. 631. 632. 633. 634. 635. 636. 637. 638. 639. 640. 641. 642. 643. 644. 645. 646. 647. 648. 649. 650. 651. 652. 653. 654. 655. 656. 657. 658. 659. 660. 661. 662. 663. 664. 665. 666. 667. 668. 669. 670. 671. 672. 673. 674. 675. 676. 677. 678. 679. 680. 681. 682. 683. 684. 685. 686. 687. 688. 689. 690. 691. 692. 693. 694. 695. 696. 697. 698. 699. 700. 701. 702. 703. 704. 705. 706. 707. 708. 709. 710. 711. 712. 713. 714. 715. 716. 717. 718. 719. 720. 721. 722. 723. 724. 725. 726. 727. 728. 729. 730. 731. 732. 733. 734. 735. 736. 737. 738. 739. 740. 741. 742. 743. 744. 745. 746. 747. 748. 749. 750. 751. 752. 753. 754. 755. 756. 757. 758. 759. 760. 761. 762. 763. 764. 765. 766. 767. 768. 769. 770. 771. 772. 773. 774. 775. 776. 777. 778. 779. 780. 781. 782. 783. 784. 785. 786. 787. 788. 789. 790. 791. 792. 793. 794. 795. 796. 797. 798. 799. 800. 801. 802. 803. 804. 805. 806. 807. 808. 809. 810. 811. 812. 813. 814. 815. 816. 817. 818. 819. 820. 821. 822. 823. 824. 825. 826. 827. 828. 829. 830. 831. 832. 833. 834. 835. 836. 837. 838. 839. 840. 84

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[illegible]

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

DEFINITION STATION AREA PLAN RATIO 1 RATIO 2 RATIOS APPLIED TO FLOWS
 1.00 .50

| | | | | | |
|---------------|---|--------|---|---------|---------|
| HYDROGRAPH AT | 1 | 0.25 | 1 | 104.00 | 5704 |
| | (| 23.90) | (| 500.41) | 150.20) |
| ROUTED TO | | 0.25 | 1 | 10397 | 4765 |
| | (| 23.90) | (| 204.40) | 174.02) |
| ROUTED TO | | 0.50 | 1 | 10705 | 4767 |
| | (| 27.56) | (| 204.74) | 174.93) |
| ROUTED TO | | 0.25 | 1 | 10410 | 4774 |
| | (| 27.56) | (| 205.03) | 175.17) |

SUPMARY OF DAM SAFETY ANALYSIS

PLAN 1 INITIAL VALUE SPILLWAY CREST TOP OF DAM
 ELEVATION 331.00 331.00
 STORAGE 1440. 1440.
 OUTFLOW 3910.

| RATIO
OF
PHE | MAXIMUM
RECEIVING
W.S. FLEV | MAXIMUM
DEPTH
OVER DAM | MAXIMUM
STORAGE
AC-FT | MAXIMUM
OUTFLOW
CFS | DURATION
OVER TOP
HOURS | TIME OF
MAX OUTFLOW
HOURS | TIME OF
FAILURE
HOURS |
|--------------------|-----------------------------------|------------------------------|-----------------------------|---------------------------|-------------------------------|---------------------------------|-----------------------------|
| 1.00 | 74.45 | 2.45 | 3076. | 10397. | 14.00 | 46.00 | 0.00 |
| .50 | 73.50 | .50 | 2728. | 4755. | 5.00 | 46.00 | 0.00 |

PLAN 1 STATION 3

| RATIO | MAXIMUM
FLOW-CFS | MAXIMUM
STAGE-FT | TIME
HOURS |
|-------|---------------------|---------------------|---------------|
| 1.00 | 10395. | 305.0 | 46.00 |
| .50 | 4767. | 303.2 | 46.00 |

PLAN 1 STATION 4

| RATIO | MAXIMUM
FLOW-CFS | MAXIMUM
STAGE-FT | TIME
HOURS |
|-------|---------------------|---------------------|---------------|
| 1.00 | 10419. | 302.1 | 47.00 |
| .50 | 4774. | 301.1 | 48.00 |

.....
FLUX STOPPED TACKLE (HEC-1)
DAM SAFETY VISIT JULY 1975
LAST MODIFICATION 26 FEB 76
.....

STABILITY ANALYSIS

APPENDIX F

TAMS

Job No. 1551-07

Project PHASE I INSPECTION

Subject STABILITY ANALYSIS - OVERFLOW SECTION
BEAVER DAM LAKE

Sheet 1 of

Date 5/9/80

By JP

Ch'k. by AD

Assumptions:

1. See Notes on the Sketch.
2. Since Spillway is masonry (brick & stone) & concrete, the unit weight is assumed as 145 lbs/cuft.
3. During overturning, it is assumed that toe of spillway is about 28ft from upstream face.
4. Frictional Resistance is assumed to develop at the entire base i.e. 51 feet.
5. Internal Resistance of Glacial till is equal to angle of repose which is about 35°.

CASES - LOADING CONDITIONS

- CASE I : Normal loading condition ; normal lake level without ice load ;
- CASE II : Normal loading condition ; normal lake level with ice load.
- CASE III : Unusual loading condition ; Reservoir level equal to $\frac{1}{2}$ PMF
- CASE IV : Extreme loading condition ; Reservoir level equal to PMF.
- CASE V : Unusual loading condition ; Normal lake level, without ice load and earthquake.

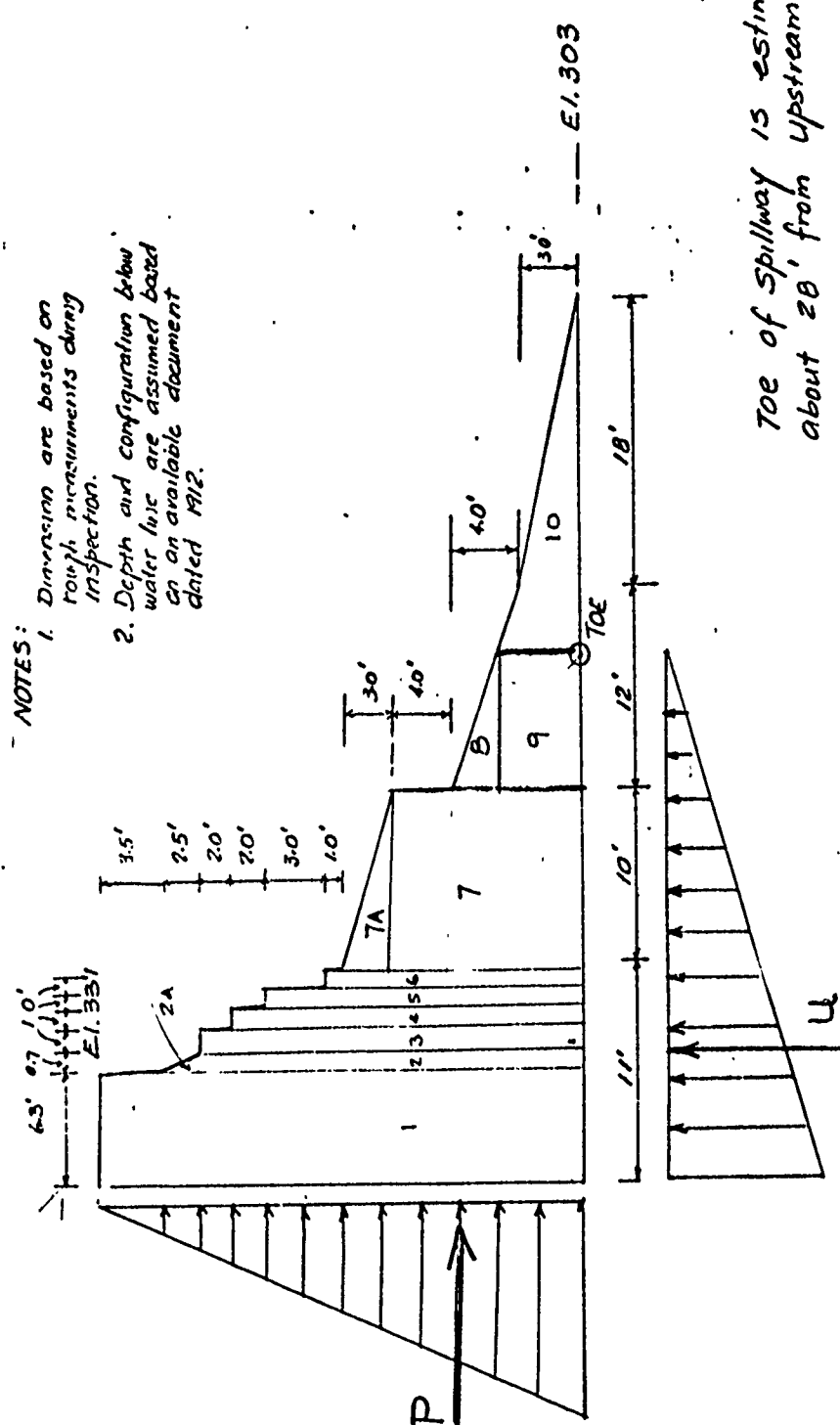
STABILITY CRITERIA:

The stability criteria against overturning and sliding were evaluated as follows.

Overturning - Stability is considered adequate if the resultant of all forces falls within the middle third of the base under the normal loading condition, and within middle half of the base under the unusual and extreme loading conditions.

Sliding - Stability along the base of the structure is evaluated using the friction factor of safety (FFS) which is equal to $V \tan \phi / H$, where V is the sum of vertical forces acting on the base, H is the sum of all horizontal forces and $\tan \phi$ is Friction Factor. The stability with respect to sliding is considered adequate if the FFS exceeds 1.50 under normal loading conditions, 1.25 under unusual loading conditions and 1.1 under extreme loading conditions.

- NOTES:
1. Dimensions are based on rough measurements during inspection.
 2. Depth and configuration below water line are assumed based on an available document dated 1912.



Toe of Spillway is estimated at about 20' from upstream face.

SPILLWAY SECTION

| | | | |
|---------------------------|---|--|-------|
| NYS DEPT OF ENVN. & CONS. | | TIPPETTS-ABBETT-McCARTHY-STRATTON
ENGINEERS and ARCHITECTS NEW YORK | |
| PHASE I INSPECTION | DAM STABILITY ANALYSIS
BEAVER DAM LAKE | BY: JP | DATE: |
| | | DRAWING NUMBER: | 1A |

TAMS

Job No. 1551-07

Sheet 2 of 11

Project PHASE I INSPECTION

Date 5/9/80

Subject STABILITY ANALYSIS - OVERFLOW SECTION

By JP

BEAVER DAM LAKE

Ch'k. by AD

A. DEAD LOADS

| | F_v
K. KIPS | M_R
KF |
|---|-------------------------|-------------|
| $W_1 = 0.145 \times 28 \times 6.3$ | $= 25.58 \times 24.85'$ | $= 635.66$ |
| $W_2 = 0.145 \times 22 \times 0.7$ | $= 2.23 \times 21.35'$ | $= 47.61$ |
| $W_{2A} = 0.145 \times \frac{1}{2} \times 2.5 \times 0.7$ | $= 0.13 \times 21.47'$ | $= 2.79$ |
| $W_3 = 0.145 \times 22 \times 1.0$ | $= 3.19 \times 20.5'$ | $= 64.60$ |
| $W_4 = 0.145 \times 20 \times 1.0$ | $= 2.90 \times 19.5'$ | $= 56.55$ |
| $W_5 = 0.145 \times 18 \times 1.0$ | $= 2.61 \times 18.5'$ | $= 48.29$ |
| $W_6 = 0.145 \times 15 \times 1.0$ | $= 2.18 \times 17.5'$ | $= 38.15$ |
| $W_7 = 0.145 \times 11.0 \times 10$ | $= 15.95 \times 12.0'$ | $= 191.40$ |
| $W_{7A} = 0.145 \times \frac{1}{2} \times 10 \times 13$ | $= 2.18 \times 13.67'$ | $= 29.73$ |
| $W_8 = 0.145 \times \frac{1}{2} \times 7 \times 1.75$ | $= 0.89 \times 4.67'$ | $= 4.15$ |
| $W_9 = 0.145 \times \frac{1}{2} \times 5.25 \times 7$ | $= 5.32 \times 3.50'$ | $= 18.65$ |

$\Sigma F_v = 63.15 \text{ Kips.}$

$\Sigma M_R = 1137.58 \text{ KF}$

$$\bar{x} = \frac{1137.58}{63.15} = 18.01 \text{ ft.}$$

During the sliding additional vertical load (F_{W10}) would act. (See Note 4).

$$W_{10} = 0.145 \times \frac{1}{2} \times 23 \times 5.25 = 8.75 \text{ Kips}$$

TAMS

Job No. 1511-07

Sheet 3 of 11

Project PHASE I INSPECTION - BEAVER DAM LAKE

Date 5/9/80

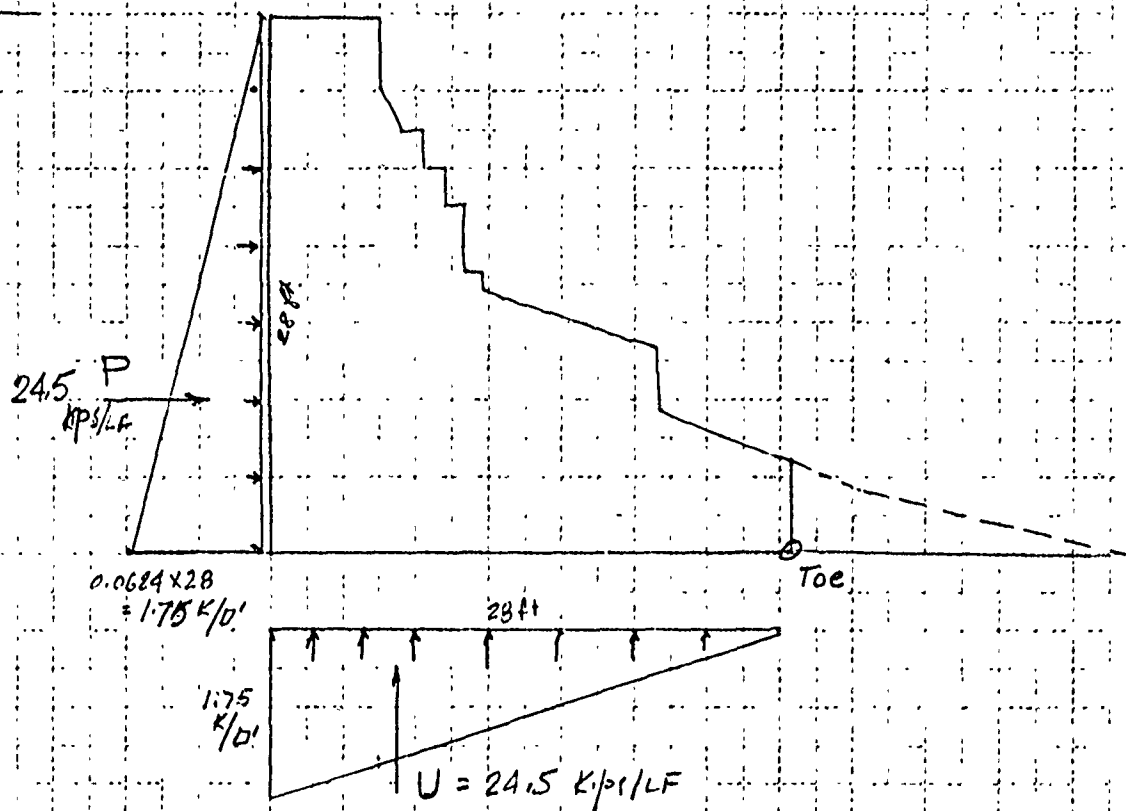
Subject STABILITY ANALYSIS

By JP

BEAVER DAM LAKE

Ch'k. by AD

B. Hydrostatic Forces



$\Sigma M @ \text{Toe}$

$$P = \frac{1}{2} \times 1.75 \times 28 = 24.5 \times 9.33 = 228.59 \rightarrow$$

$$U = \frac{1}{2} \times 1.75 \times 28 = 24.5 \times 18.67 = 457.42 \uparrow$$

$$\underline{686.01 \uparrow}$$

TAMS

Job No. 1555-07

Sheet 4 of 11

Project PHASE 1 INSPECTION — BEAVER DAM LAKE

Date 5/9/80

Subject DAM STABILITY ANALYSIS

By JP

BEAVER DAM LAKE

Ch'k. by AD

C. ICE FORCES

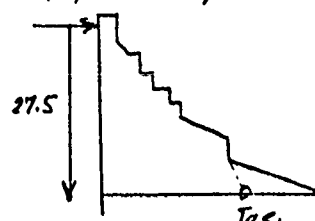
a) According to Corps criteria ice pressure of 5000 lbs/ft^2

b) Ice thickness 1 foot

EM @ Toe

$$5.0 \times 1 \times 27.5 = 137.50 \text{ K.F.}$$

$$5000 \text{ lb} \times 1 = 5.0 \text{ K.F.}$$



CASE 1. NORMAL OPERATING CONDITION — WITHOUT ICE.

| | F_v | F_H | M_R | M_o |
|----------------|--------------|---------------|--------------------|-------------------|
| A. Dead Load | 63.16 | 0 | 1137.6 | 0 |
| B. Hydrostatic | -24.50 | 24.5 | 0 | 686.0 |
| | <u>38.66</u> | <u>24.5 K</u> | <u>1137.6 K.F.</u> | <u>686.0 K.F.</u> |
| Dead Load | <u>0.75</u> | | | |
| | <u>47.41</u> | | | |

(Overturning)

(See Note 4)

RESULTANT LOCATION:

$$\Sigma M_{DL+Hyd} = \Sigma M_R - M_o = 1137.6 - 686.0 = 451.60 \text{ K.F.}$$

$$\text{Resultant location} = \frac{451.60}{38.66} - \frac{28.0}{3} = 2.35 \text{ ft inside middle third}$$

$$\bar{e} = \frac{28.0}{2} - \frac{451.60}{38.66} = 2.32 \text{ ft downstream from base of}$$

$$p = \frac{38.66}{28} \left(1 \pm \frac{6 \times 2.32}{28.0} \right) \times \frac{1000}{144} = 10 \pm 5 = \begin{cases} 15.0 \text{ psi @ Toe} \\ 5.0 \text{ psi @ heel} \end{cases}$$

SLIDING FACTOR

Friction factor of Safety Considered

$$FFS = \frac{47.41 \tan 35^\circ}{24.5}$$

Heard from $\phi = 35^\circ$

$$= 1.35 < 1.50$$

TAMS

Job No. 1511
 Project PHASE I INSPECTION - BEAVER DAM LAKE
 Subject DAM STABILITY ANALYSIS
BEAVER DAM LAKE

Sheet 5 of 11
 Date 5/9/80
 By JP
 Ch'k. by AD

CASE II NORMAL OPERATING CONDITION - WITH ICE LOAD.

| | F _V | F _H | M _R | M _O |
|----------------|-------------------|----------------|----------------|---------------------|
| A. Dead load | 63.16 | 0.0 | 1137.6 | 0 |
| B. Hydrostatic | -24.50 | 24.5 | 0 | 686.0 ↑ |
| C. Ice load | 0 | 5.0 | 0 | 137.5 ↑ |
| | 38.66 | 29.5 | 1137.6 | 823.5 (overturning) |
| | 8.75 ⁺ | (See Note 4) | | |
| | 47.41 | | | |

$$\Sigma M = 1137.6 - 823.5 = 314.10 \text{ @ Toe}$$

314.10 Hyd
+ Ice

Resultant location : $\frac{314.10}{38.66} - \frac{28.0}{3} = -1.21 \text{ ft outside middle third. (d/s)}$

$$\bar{e} = \frac{28.0}{2} - \frac{314.10}{38.66} = 5.87' \text{ downstream from } \phi \text{ of base}$$

$$p = \frac{38.66}{28} \left(1 \pm \frac{6 \times 5.87}{28.0} \right) \times \frac{1000}{144} = 10 \pm 13 = \begin{cases} 23 \text{ psi @ Toe} \\ -2 \text{ psi @ heel} \end{cases}$$

SLIDING FACTOR

friction factor of Safety considered

$$FFS = \frac{47.41 \tan 35^\circ}{29.5} = 1.13 < 1.5$$

TAMS

Job No. 1551-07

Sheet 6 of 11

Project PHASE I INSPECTION

Date 5/10/80

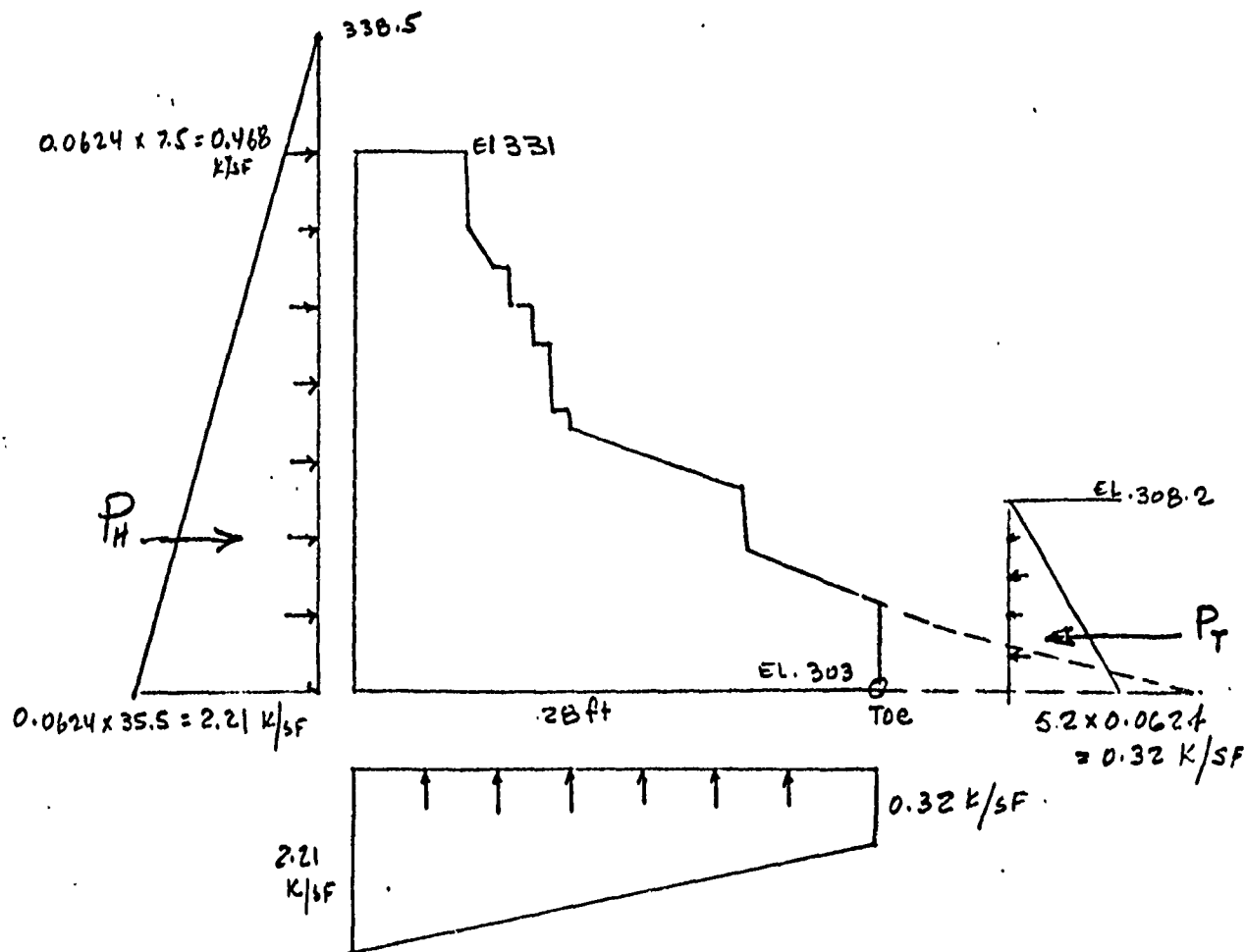
Subject DAM STABILITY ANALYSIS

By JP

BEAVER DAM LAKE

Ch'k. by AD

CASE III $\frac{1}{2}$ PMF (EL. 338.5)



a. Dead load (See Computation Sheet #2)

$$F_v = 63.16 \quad E M \ 1137.58$$

b. Hydrostatic loads.

$$P_H = \frac{1}{2} [2.21 + 0.47] 28 = 37.52 \times 10.97 = 411.59 \downarrow$$

$$P_T = \left\{ \frac{1}{2} \times 0.32 \times 5.2 \right\} 0.6 = 0.50 \times 1.73 = 0.87 \uparrow$$

$$U = \frac{1}{2} \times [2.21 + 0.32] 28 = 35.42 \times 17.48 = 619.14 \downarrow$$

TAMS

Job No. 1551-07

Sheet 7 of 11

Project PHASE 1 INSPECTION

Date 5/18/80

Subject DAM STABILITY ANALYSIS

By JP

BEAVER DAM LAKE

Ch'k. by AD

| | F_v | F_H | M_R | M_O |
|-------------|----------|----------------|---------|---------|
| Dead Load | 63.16 ↓ | 0 | 1137.58 | 0 |
| Hydrostatic | -35.42 ↑ | 37.02 | 0.87 | 1060.73 |
| | 27.74 ↓ | 37.02 | 1138.45 | 1060.73 |
| | 8.75 ↓ | | | |
| | 36.49 | (sliding case) | | |

RESULTANT LOCATION

$$\Sigma M = \Sigma M_R - M_O = 1138.45 - 1060.73 = 77.72 \text{ KF.}$$

$$\text{Resultant location: } \frac{77.72}{27.74} - \frac{28.0}{3} = 2.8 - 9.3 = -6.5 \text{ ft out side downstream middle third.}$$

$$e = \frac{28}{2} - \frac{77.72}{27.74} = 14 - 2.8 = 11.2 \text{ downstream from base E.}$$

$$p = \frac{27.74}{28} \left(1 \pm \frac{6 \times 11.2}{28} \right) \frac{1000}{144} = 7 \pm 17 \left\{ \begin{array}{l} 24 \text{ psi @ } \tau \\ -10 \text{ psi @ } \text{heel} \end{array} \right.$$

SLIDING FACTOR

$$FFS = \frac{36.49 \tan 35^\circ}{37.02} = 0.69 < 1.25$$

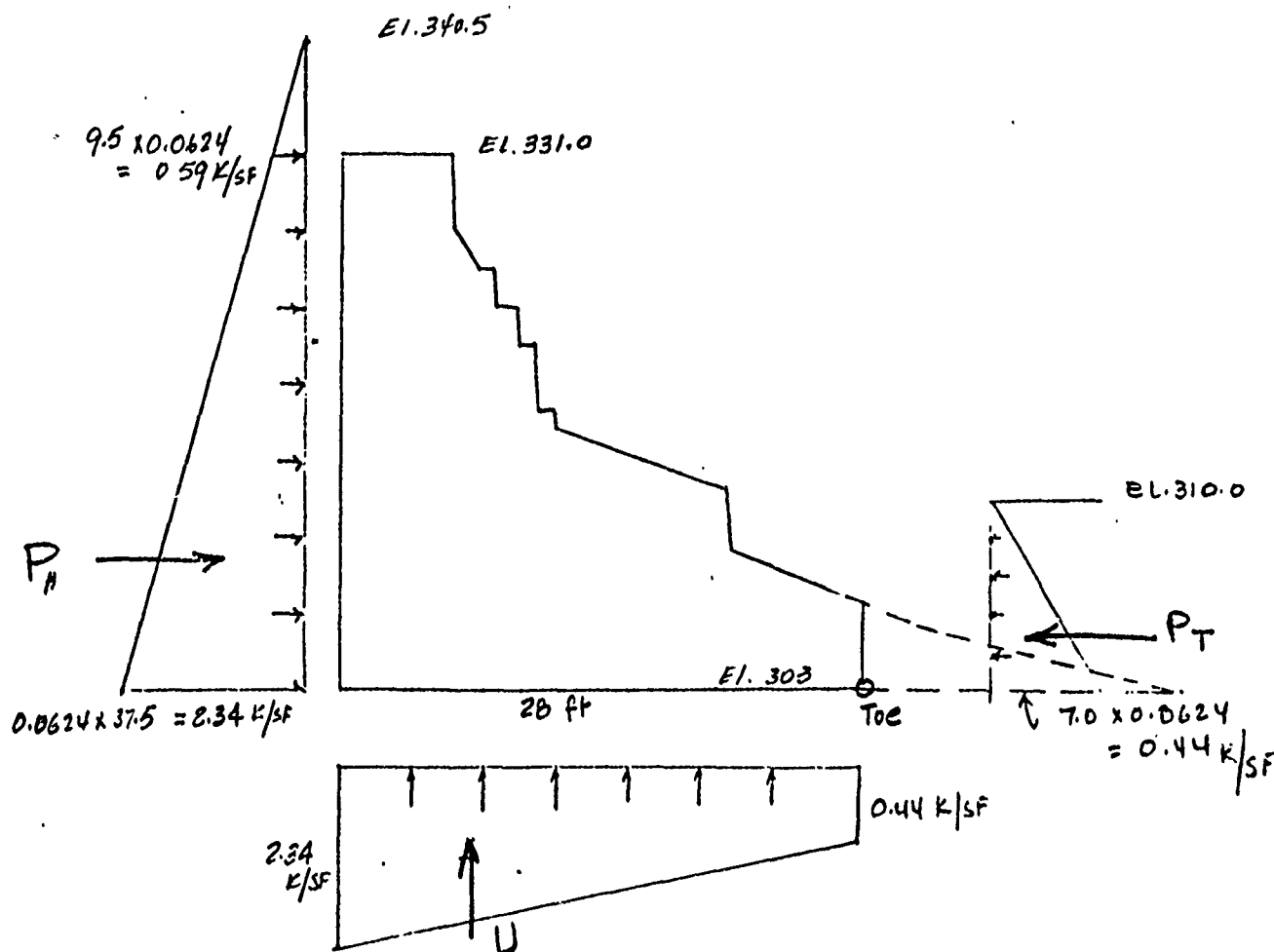
TAMS

Job No. 1551-07
 Project PHASE I INSPECTION
 Subject DAM STABILITY ANALYSIS
BEAUCER DAM LAKE

Sheet 8 of 11
 Date 5/18/80
 By JP
 Ch'k. by AD

CASE IV

PMF (El. 340.5)



a. Dead load (See Computation sheet #2)

$$F_v = 63.16 \quad \Sigma M = 1137.58$$

b. Hydrostatic loads

$$P_H = \frac{1}{2} [2.34 + 0.61] 28 = 41.30 \times 11.2 = 462.56 \downarrow$$

$$P_T = \frac{1}{2} \times 0.44 \times 7.0 \times 0.6 = 0.92 \times 2.33 = 2.14 \uparrow$$

$$U = \frac{1}{2} [2.34 + 0.44] 28 = 38.92 \times 17.19 = 669.03 \downarrow$$

TAMS

Job No. 1551-07

Sheet 9 of 11

Project PHASE I INSPECTION

Date 5/18/80

Subject DAM STABILITY ANALYSIS

By J.P

BEAVER DAM LAKE

Ch'k. by AD

| | F_v | F_H | M_R | M_O |
|--------------------------------|--------------|--------------|----------------|----------------|
| Dead load | 63.16 | 0 | 1131.58 | 0 |
| Hydrostatic | -36.92 | 40.38 | 2.14 | 1131.59 |
| | <u>24.24</u> | <u>40.38</u> | <u>1139.72</u> | <u>1131.59</u> |
| | <u>8.75</u> | | | |
| $E F_v = 32.99$ (Sliding Case) | | | | |

RESULTANT LOCATION

$$\Sigma M = \Sigma M_R - M_O = 1139.72 - 1131.59 = -8.13$$

$$\text{Resultant location} = -\frac{8.13}{24.24} - \frac{28}{3} = -0.3 - 9.3 = -9.6 \text{ ft Out side downstream middle third}$$

$$e = \frac{28}{2} - \left(-\frac{8.13}{24.24} \right) = 14 + 0.3 = 14.3 \text{ ft downstream from base } \phi$$

$$p = -\frac{24.24}{21.58} \left(1 + \frac{6 \times 14.3}{28} \right) \frac{1000}{144} = -8 \pm 25 = \begin{pmatrix} 33 \text{ psi @ Toe} \\ -17 \text{ psi @ Heel} \end{pmatrix}$$

SLIDING FACTOR

$$FFS = \frac{32.99 \tan 35^\circ}{40.38} = 0.57 < 1.1$$

TAMS

Job No. 1551-11

Sheet 10 of 11

Project Beaver Dam Lake

Date 12 May 80

Subject Dynamic Stability

By G. D. B.

BEAVER DAM LAKE

Ch'k. by -1. JP

CASE IV. NORMAL OPERATING CONDITION - With Earthquake Load

A. LOCATE Center of GRAVITY OF WALL

| Sections | Area
(ft ²) | X (ft
from toe) | y (ft
from toe) | AX (ft ³) | Ay (ft ³) |
|----------|----------------------------|--------------------|--------------------|-----------------------|-----------------------|
| 1 | 176.4 | 24.85 | 14.0 | 4383.5 | 2469.6 |
| 2 | 15.4 | 21.35 | 11.0 | 328.8 | 169.4 |
| 2A | 0.9 | 21.47 | 22.83 | 19.3 | 20.5 |
| 3 | 22.0 | 20.5 | 11.0 | 451.0 | 242.0 |
| 4 | 20.0 | 19.5 | 10.0 | 390.0 | 200.0 |
| 5 | 19.0 | 18.5 | 9.0 | 333.0 | 162.0 |
| 6 | 15.0 | 17.5 | 7.5 | 262.5 | 112.5 |
| 7 | 110.0 | 12.0 | 5.5 | 1320.0 | 605.0 |
| 7A | 15.0 | 13.7 | 12.0 | 205.5 | 180.0 |
| 8 | 6.1 | 4.7 | 5.83 | 28.7 | 35.6 |
| 9 | 36.8 | 3.5 | 2.63 | 128.8 | 96.8 |
| Total | 435.6 | | | 7851.1 | 4293.1 |

$$\bar{X} = 18.1 \text{ ft} \quad \bar{Y} = 9.95 \text{ ft}$$

B. FORCES

| | F _V
(K) | F _H
(K) | M _R ↗
(KF) | M _O ↗
(KF) |
|-----------------------|-----------------------|-----------------------|--------------------------|--------------------------|
| Dead Load | 63.16 ↓ | 0 | 1137.6 | 0 |
| Hydrostatic Uplift | 24.5 ↑ | 0 | 0 | 4574.0 |
| Hydrodynamic (1)† | | 1.78 → | 0 | 19.9 |
| Earthquake Force (2)‡ | | 3.16 → | 0 | 31.13 |
| Hydrostatic Pressure | 0 | 24.5 → | 0 | 228.6 |
| | 38.7 | 29.4 | 1138 | 737.0 |
| Dead Load | 8.75 (See note 4) | | | |
| | 47.45 | | | |

TAMS

Job No. 1551-11

Sheet 11 of 11

Project Beaver Dam Lake

Date 12 May 80

Subject Dynamic Stability Analysis

By G. D. 30

BEAVER DAM LAKE

Ch'k. by _____

CASE III Continued

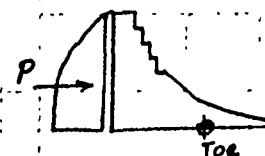
(1) Hydrodynamic Forces & Moments:

Zangars Method: $P = (C) n w h^2$ where $C = 0.726$ when $\theta = 0^\circ$

$$P = 0.726 (0.05) (0.0624) (28)^2 = 1.78 \text{ Kips}$$

↑
Zone 2

$$M_p \curvearrowright = 1.78 \{ (0.4) (28) \} = 19.9 \text{ K-ft.}$$



(2) Dynamic Forces and Moments:

$$\text{Zone 2} \Rightarrow n = 0.05$$

$$F_v = 63.16$$

$$\therefore W_D = 0.05 (63.16) = 3.16 \text{ K} \rightarrow$$

$$M_{WD} \curvearrowright = 3.16 \bar{y} = 3.16 (9.55) = 31.13 \text{ KF}$$

Location of Resultant

$$X_R = \frac{1188 \cdot 737.0}{38.7} = 10.4 \text{ ft. (Positive, therefore okay)}$$

Sliding Factor of Safety

$$FFS = \frac{\sigma_v \tan \phi}{\Sigma F_H} = \frac{47.5 \tan 35^\circ}{29.4} = 1.13 < 1.25$$

REFERENCES

APPENDIX G

References

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